# Résumé of Miguel Sainz

**Work Address**

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Résumé updated on July 2004.

## Professional Goals

To work in a production environment developing tools and new technologies in the areas of computer graphics and image processing.

## Education

| | |
|---|---|
| 1999 - 2003 | **University of California, Irvine**. Ph.D. in Electrical and Computer Engineering. |
| 1988 - 1996 | **Technical University of Catalonia (UPC)**, **Barcelona, Spain**. M.Sc. and B.Sc. in Electrical Engineering with major in power electronics. |

## Work Experience

| | |
|---|---|
| 07/04 - pres. | **Developer Technology Engineer**. NVIDIA Corporation, European Division. Providing technical support to developers on graphics and NVIDIA hardware |
| 07/03 - 07/04 | **Postdoctoral Researcher**. School of Information and Computer Science, University of California, Irvine. Researching and teaching in computer graphics and computer vision. |
| 09/99 - 07/03 | **Graduate Research Assistant**. Electrical and Computer Engineering Dept., The Henry Samueli School of Engineering, University of California, Irvine, CA. Researching on Image Based Modeling and Rendering techniques. |
| 12/98 - 07/99 | **Java Instructor**, Training Services Department of Sun Microsystems, Barcelona, Spain. Teaching on-site programming courses for IT companies. |
| 09/98 - 01/99 | **Instructor**. Multimedia engineering, computer graphics and virtual reality. Center for Integration of Technologies and Media (CiTEM), La Salle School of Engineering, Ramon Llull University, Barcelona, Spain. Researching and teaching in computer graphics |
| 03/98 - 09/98 | **Research Engineer**. Technical University of Catalonia (UPC), Computer Graphics Section, Barcelona, Spain. Developing Computer Graphics projects for industrial partners. |
| 07/96 - 01/98 | **Research Engineer**, Technical University of Catalonia (UPC), Robotics and Informatics Institute, Barcelona, Spain. Developing Computer Vision projects for industrial partners. |
| 01/93 - 06/96 | **Research Student**, Cybernetics Institute (IC), Barcelona, Spain. Researching in Computer Vision. |

## Domains of Expertise

Extensive experience in the following areas:

- **realtime** and **offline rendering** and game engine programming
- **GPU shading** programming in assembly and **Cg**
- advanced **OpenGL**.
- Image processing
- **3D Computer Vision**: tracking, camera calibration, scene reconstruction.

- Java, Python, **C/C++**
- UNIX and Windows system programming.
- Network programming.

## Selected Publications

Sainz M., Pajarola R., *Point-Based Rendering Techniques*. Elsevier Journal of Computer and Graphics (C&G), to appear on Special Issue on Point Based Graphics.

Sainz M., Pajarola R., Susin T. and Mercade A., *A Simple Approach for Point-Based Object Capturing and Rendering*. IEEE Journal of Computer Graphics and Applications (CG&A), vol. 24(4):24-33, 2004.

Pajarola R., Sainz M. and Guidotti P., *Confetti: Object-Space Point Blending and Splatting*. IEEE Transactions on Visualization and Computer Graphics (TVCG), to appear.

Pajarola R., Sainz M. and Meng Y., *DMesh: Fast Depth-Image Meshing and Warping*. International Journal of Image and Graphics (IJIG), 4(4):1-29, 2004.

Sainz M., Susin A. and Bagherzadeh N., *Camera Calibration of Long Image Sequences with the Presence of Occlusions*. In Proceeding of the International Conference in Image Processing 2003 (ICIP'03), Barcelona.

Sainz M., 3D Modeling from Images and Video Streams. PhD. Thesis, University of California Irvine, July 2003.

## Professional Activities

- Member of IEEE, IEEE Computer Society, ACM and ACM Siggraph.
- Technical Committee of the IASTED Computer Graphics And Imaging Conference.
- Reviewer of the IEEE Computer Graphics and Applications Journal.
- Reviewer of the IEEE Visualization'04 Conference.
- Reviewer of the ACM Siggraph'04 Conference.
- Reviewer of the Eurographics'04 Conference.
- Reviewer of the Elsevier Journal of the Image and Vision Computing (IMAVIS).

## Patents and Copyrights

D'Zmura M., Hagedorn J. and Sainz M. *Jericho Displays. A window graphical user interface for 3D games and virtual environments*. Copyright 2001. University of California, Irvine.

# Résumé of Miguel Sainz - EXTENDED VERSION

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Résumé updated on July 2004.

## Professional Goals

To work in a production environment developing tools and new technologies in the areas of computer graphics and image processing.

## Education

| | |
|---|---|
| 1999 - 2003 | **University of California, Irvine.** Doctor of Philosophy in Electrical and Computer Engineering. The Henry Samueli School of Engineering, Dept. of Electrical Engineering and Computer Science. Degree achieved on July 8th, 2003. |
| 1996-1997 | **Technical University of Catalonia (UPC)**, **Barcelona, Spain.** 17 (out of 32) credits of the Ph.D. Program in Perception and Control Systems Engineering. |
| 1994 - 1996 | **Cybernetics Institute (IC), Barcelona, Spain**. Master of Science degree in Electrical and Electronic Engineering. Project Title: "Automatic Learning of Industrial Models Using Computer Vision, and its Application to Traffic Sign Recognition". Awarded scholarship from the IC internal program. |
| 1988 - 1994 | **Technical University of Catalonia (UPC)**, **Barcelona, Spain**. Bachelor degree in Electrical Engineering with major in power electronics. |

## Work Experience

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|---|---|
| 07/04 - pres. | **Developer Technology Engineer**. NVIDIA Corporation, European Division. Providing technical support to developers on graphics and NVIDIA hardware. |
| 07/03 - 07/04 | **Postdoctoral Researcher**. School of Information and Computer Science, University of California, Irvine. Researching and teaching in computer graphics and computer vision. |
| 09/99 - 07/03 | **Graduate Research Assistant**. Electrical and Computer Engineering Dept., The Henry Samueli School of Engineering, University of California, Irvine, CA. Researching on Image Based Modeling and Rendering techniques. |
| 12/98 - 07/99 | **Java Instructor**, Trainning Services Department of Sun Microsystems, Barcelona, Spain. Teaching on-site programming courses for IT companies. |
| 09/98 - 01/99 | **Instructor**. Multimedia engineering, computer graphics and virtual reality. Center for Integration of Technologies and Media (CiTEM), La Salle School of Engineering, Ramon Llull University, Barcelona, Spain. Researching and teaching in computer graphics |
| 03/98 - 09/98 | **Research Engineer**. Technical University of Catalonia (UPC), Computer Graphics Section, Barcelona, Spain. Developing Computer Graphics projects for industrial partners. |
| 07/96 - 01/98 | **Research Engineer**, Technical University of Catalonia (UPC), Robotics and Informatics Institute, Barcelona, Spain. Developing Computer Vision projects for industrial partners. |
| 01/93 - 06/96 | **Research Student**, Cybernetics Institute (IC), Barcelona, Spain. Researching in Computer Vision. |

## Awards

07/03 - 07/04    **UC Faculty Fellowship**. School of Information and Computer Science, University of California, Irvine, CA.

04/03 - 07/03    **Dissertation Fellowship Award**. Department Electrical and Computer Engineering, The Henry Samueli School of Engineering, University of California, Irvine, CA.

02/02    **NVIDIA Research Fellowship**. Finalist of the fellowship contest. Awarded with the latest graphics hardware product of the manufacturer.

09/99 - 09/00    **Balsells Fellowship**, Department Electrical and Computer Engineering, The Henry Samueli School of Engineering, University of California, Irvine, CA

01/94-07/96    **IC Undergraduate Fellowship**, Technical University of Catalonia (UPC), Robotics and Informatics Institute, Barcelona, Spain

## Teaching Experience

07/03 - 07/04    **University of California, Irvine, (USA).** School of Information and Computer Science. Lecturer on the subject of ICS188 Advanced Computer Graphics (20 hours). Course design and lecturing of ICS280 3D Computer Vision (20 hours) and ICS180 Computer Vision and Image Processing (20 hours).

03/00 - 06/00    **University of California, Irvine, (USA).** The Henri Samueli School of Engineering. Teaching Assistant for the course ECE 40 "C++ programming". In charge of Laboratory sessions and course grading.

01/99 - 06/99    **Sun Microsystems, Madrid, (Spain).** Trainning Services Department of Sun Microsystems, Madrid, Spain. Lecturer of Java Programming courses, C programming courses, web design courses and Introduction to Solaris OS.

09/98 - 01/99    **CITeM - La Salle, School of Engineering, Ramon Llull University, Barcelona, (Spain).** Multimedia Engineering Bachelor Program. Lecturer on the subjects Computer animation (10 hours) and Virtual Reality (10 hours).

03/98    **CITeM - La Salle, School of Engineering, Ramon Llull University, Barcelona, (Spain).** Master on Business Technologies (MBT). Lecturer on the subject Multimedia: images, voice, sound and data integration.(8 hours).

09/97    **Universidad Autonoma de Madrid, Madrid, (Spain)**. Java programming language. Lecturer on the subject: GUI and Applet programming. (10 hours).

## Domains of Expertise

Extensive experience in animation and computer graphics with special emphasis in the following areas: real-time rendering, game engine programming, GPU shading programming in assembly and Cg, OpenGL including the use of extensions, advanced data structures for multiresolution and level of detail selection, point based rendering approaches, visualization and isosurface extraction methods, image based modeling and rendering and off-line rendering using ray-tracing and photon mapping methods. Knowledge in Silicon Graphics Performer library and programming in Silicon Graphics platforms.

Extensive experience in image processing algorithm design for computer vision applications in areas such as: image enhancement, feature detection, feature tracking, image segmentation, pattern recognition. Furthermore, strong expertise in algorithms for 3D computer vision: camera calibration, stereo matching, volumetric reconstruction, scene reconstruction from images.

Extensive experience in general programming in C/C++, Java and Python. Strong knowledge in advanced data structures and numerical calculus (linear algebra, minimization, root finding and non-linear optimization). Experience on system programming (file access, memory mapped techniques, serial and parallel ports), client-server applications under Windows and UNIX. Extensive knowledge in programming

GUI and graphics applications. Experience in programming networked client-server applications under Windows and UNIX.

Experience in UNIX, Linux and Windows NT/2000/XP system administration. Proficient use of standard productivity tools and word processors. Knowledge of 3D modeling tools.

## Peer-reviewed Publications

*Journals:*

Sainz M., Pajarola R., *Point-Based Rendering Techniques*. Elsevier Journal of Computer and Graphics (C&G), to appear on Special Issue on Point Based Graphics.

Sainz M., Pajarola R., Susin T. and Mercade A., *A Simple Approach for Point-Based Object Capturing and Rendering*. IEEE Journal of Computer Graphics and Applications (CG&A), vol. 24(4):24-33, 2004.

Pajarola R., Sainz M. and Guidotti P., *Confetti: Object-Space Point Blending and Splatting*. IEEE Transactions on Visualization and Computer Graphics (TVCG), to appear.

Pajarola R., Sainz M. and Meng Y., *DMesh: Fast Depth-Image Meshing and Warping*. International Journal of Image and Graphics (IJIG), 4(4):1-29, 2004.

*Conferences:*

Sainz M., Pajarola R. and Lario R., *Points Reloaded: Point-Based Rendering Revisited*. In Proceedings of the EG Symposium on Point-Based Graphics, pp. 121-128, 2004.

Sainz M., Pajarola R., Susin A., *Photorealistic Image Based Objects from Uncalibrated Images.* In Posters of the IEEE Visualization Conference 2003 (VIS'03).

Sainz M., Susin A. and Bagherzadeh N., *MTMesh: Image Based Mesh Reconstruction and Rendering*. In Proceedings of the IAESTED Conference in Visualization, Imaging and Image Processing (VIIP'03).

Sainz M., Susin A., Cervantes, A. and Bagherzadeh N., *Persepolis: Recovering history with a handheld camera*. In Posters of Eurographics 2003 (EG'03).

Sainz M., Susin A. and Bagherzadeh N., *Camera Calibration of Long Image Sequences with the Presence of Occlusions*. In Proceeding of the International Conference in Image Processing 2003 (ICIP'03), Barcelona.

Sainz M., Bagherzadeh N. and Susin A., *Hardware Accelerated Voxel Carving*. In 1st Ibero-American Symposium in Computer Graphics (SIACG 2002), July 2-5, 2002 Guimarães, Portugal. pp 289-297.

Sainz M., Bagherzadeh N. and Susin A., *Carving 3D Models from Uncalibrated Views*. In 5th IASTED International Conference Computer Graphics and Imaging (CGIM 2002) August 12-14, 2002 Kauai, Hawaii, USA. pp 144-149.

Sainz M., Bagherzadeh N. and Susin A., *Recovering 3D Metric Structure and Motion from Multiple Uncalibrated Cameras*. In IEEE Proc. International Conference on Information Technology: Coding and Computing, pp 268-273, 2002.

Alquézar R., Sanfeliu A. and Sainz M.: *Experimental Assesment of Connectionist Regular Inference from Positve and Negative Examples*. In Proc. of the VII Spanish Symposium on Pattern Recognition and Image Analisys, Bellaterra, 21-25 April (1997).

Sainz M. and Sanfeliu A., *A syntactical approach to learn and identify bidimensional image models*. In Proc. of the VII Spanish Symposium on Pattern Recognition and Image Analisys, Bellaterra, 21- 25 April (1997).

Sanfeliu A. and Sainz M., *Automatic recognition of bidimensional models learned by grammatical inference in outdoor scenes*. In Advances in Structural and Syntactical Pattern Recognition, Proc. of the 6th IAPR International Workshop on Structural and Syntactic Pattern Recognition (SSPR'96), Springer-Verlag, LNCS-1121, pp.160 - 169. ISBN 3-540-61577-6.

Sainz M. and Sanfeliu A., *Learning bidimensional context dependent models using a context sensitive language*. In Proc. of the 13th International Conference on Pattern Recognition, Viena, 25- 29 August 1996.

Sanfeliu A. and Sainz M., *Automatic Model Learning Using Computer Vision*. In Proceedings of the XVI Spanish Worshop in Automatics, San Sebastian, 27-29 Set, (1995).

Sainz M. and Sanfeliu A., *A first approach to learn the model of traffic signs using connectionist and syntactic methods*. In Proc. of the VI Spanish Symposium on Pattern Recognition and Image Analisys, Cordoba, 3-6 April (1995).

## Other Publications

*Thesis:*

Sainz M., 3D Modeling from Images and Video Streams. PhD. Thesis, University of California Irvine, July 2003.

Sainz M., Automatic Learning of Industrial Models Using Computer Vision and its Application to Traffic Sign Recognition. BSc/MSc Thesis, July 1996.

*Conferences:*

Villa-Uriol M., Sainz M., Kuester F. and Bagherzadeh N., *Automatic creation of three-dimensional avatars*. In Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 5013 (2003), January 21-22, 2003 Santa Clara, California, USA. pp 14-25.

*Technical Reports:*

Pajarola R. and Sainz M., *Stream-Processing Point Data*. Technical Report UCI-ICS-04-02, Department of Computer Science, University of California Irvine, 2004.

Sankar K., Meenakshisundaram G., Pajarola R. and Sainz M., *Point Light Field for Point Rendering Systems*. Technical Report UCI-ICS-03-28, Department of Computer Science, University of California Irvine, 2003.

Pajarola R., Sainz M. and Guidotti P., *Object-Space Blending and Splatting of Points*. Technical Report UCI-ICS-03-01, The School of Information & Computer Science, University of California Irvine, 2003.

Pajarola R., Sainz M. and Meng Y., *Depth-Mesh Objects: Fast Depth-Image Meshing and Warping*. Technical Report UCI-ICS-03-02, The School of Information & Computer Science, University of California Irvine, 2003.

Pajarola R., Meng Y. and Sainz M., *Fast Depth-Image Meshing and Warping*. Technical Report UCI-ECE-02-02, The Henry Samueli School of Engineering, University of California Irvine, 2002.

Sainz, M.: *Robotical Feeder of Surgical Needles Threading Machine*, Technical Report of the Robotics and Informatics Institute, IRI-DT-9801, February 1997

Sainz M., Thomas F. and Torras C., *Rock Granularity Estimation by Laser Scanning*, Technical Report of the Robotics and Informatics Institute, IRI-DT-9707, November 1997.

Najera J. and Sainz M., *Introduction to Java*, Technical Report of the Robotics and Informatics Institute, IRI-DT-9706 september 1997.

Jimenez P., Najera J. and Sainz M., *Robotical Feeder of Surgical Needles Threading Machine*, Technical Report of the Robotics and Informatics Institute, IRI-DT-9705 September 1997.

Sainz M. and Sanfeliu A., *Automatic learning of industrial models using computer vision and its application to traffic sign recognition*, Technical Report of the Cybernetics Institute, IC-DT-9613, July 1996.

## Talks and presentations

*Oral presentations:*

- Point-based rendering demonstration at the IEEE Visualization Conference 2003 (VIS'03).
- Point-based rendering demonstration at the NVIDIA Booth at the ACM Siggraph 2003 Expo.
- Talk entitled "Advanced Geometry and Texture Blending" at the 2003 NVIDIA-U Conference, July 23-25, 2003.
- Talk entitled "Advanced techniques in computer graphics: Image Based Modeling and Rendering", for the class Psych 114I Interactive Computer Graphics, June 3rd 2003.
- Conference presentation at the 5th IASTED International Conference Computer Graphics and Imaging (CGIM 2002) August 12-14, 2002 Kauai, Hawaii, USA.
- Conference presentation at the IEEE International Conference on Information Technology: Coding and Computing, April 8-10, 2002.
- Talk entitled "Image Based Modeling and Rendering"
- Talk entitled "A first approach to traffic sign learning using connectionist and syntactic methods" at the VI Spanish Symposium on Pattern Recognition and Image Analysis, Córdoba, 3-6 April (1995).

*Poster presentations:*

- Posters of the IEEE Visualization Conference 2003 (VIS'03).
- Research Review 2003, The Henry Samueli School of Engineering, University of California Irvine, California, USA.
- Research Review 2002, The Henry Samueli School of Engineering, University of California Irvine, California, USA.
- Poster presentation entitled *A syntactical approach to learn and identify bidimensional image models* at the VII Spanish Symposium on Pattern Recognition and Image Analysis, Bellaterra, 21-25 April (1997).
- Poster presentation entitled *Learning bidimensional context dependent models using a context sensitive language* at the 13th International Congress on Pattern Recognition, Vienna, 25-30 August 1996.

## Collaborators

*Researchers:*

- Renato Pajarola, University of California at Irvine.
- Gopi Meenakshisundaram, University of California at Irvine.
- Antonio Susín, Technical University of Catalonia (UPC).
- Mike D'Zmura, University of California, Irvine.

*Graduate Advisors:*

- Nader Bagherzadeh, University of California at Irvine.
- Antonio Susín, Technical University of Catalonia (UPC).

*Advisee Students:*

- Albert Mercade, MSc Thesis at the University of California at Irvine.
- Albert Cervantes, Undergraduate projects at the University of California at Irvine.

## Professional Activities

- Member of IEEE, IEEE Computer Society, ACM and ACM Siggraph.
- Technical Committee of the IASTED Computer Graphics And Imaging Conference.
- Reviewer of the IEEE Computer Graphics and Applications Journal.
- Reviewer of the IEEE Visualization'04 Conference.
- Reviewer of the ACM Siggraph'04 Conference.
- Reviewer of the Eurographics'04 Conference.

- Reviewer of the Elsevier Journal of the Image and Vision Computing (IMAVIS).

## Patents and Copyrights

D'Zmura M., Hagedorn J. and Sainz M. *Jericho Displays. A window graphical user interface for 3D games and virtual environments*. Copyright 2001. University of California, Irvine.

# Miguel Sainz's participation in Projects

## Revicat: The Remote Virtual Catwalk



**Description:** The proposed industry-partnered project consists of developing a client-server system to visualize and simulate in 3D space garment worn by a virtual character constructed from images of a real person.

**Duration:** 10/2003 - 10/2004.

**Personal Role:** Designing and directing the development of the character reconstruction form images. GPU algorithm development for cloth animation on an articulated character.

**Details:** The simulator allows to change the physical properties of the cloth, thus changing the dynamic behavior of the garments in real-time using the GPU when available. The different garments can be created using standard 2D garment patterns and then attached in 3D space to the virtual character. The 3D visualization process is designed to be feasible for a wide range of local or remote clients with none to full 3D hardware acceleration capabilities and broadband internet connection.

## SPOC: Simple Point-based Object Capturing



**Description:** The goal of this work was to develop a complete automatic pipeline to capture, process and render point-based models from images of real objects.

**Duration:** 09/2003 - 11/2003.
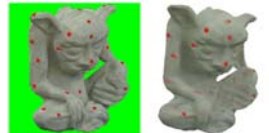
**Personal role:** Developing the complete image based modeling pipeline from image acquisition and calibration to reconstruction and point color estimation. Also developing the hardware accelerated rendering pipeline.

**Details:** The input to our system is an uncalibrated video-sequence showing different perspectives of the object to model. The proposed solution starts with a calibration of the input sequence based on feature detection and a divide and conquer linear calibration technique. The calibration information is then used to obtain a cloud of points of the surface of the object using a method inspired by the visual hull and voxel carving techniques. Then a post-process of the points is performed to smooth the reconstructed points positions and normal orientations. Finally a hardware accelerated multi-resolution point-based rendering pipeline is used to obtain high quality images of the reconstructed objects at interactive frame rates.

## Confetti: a Point Based Rendering System



**Description:** In this project we developed a novel point-based rendering approach based on object-space point interpolation of densely sampled surfaces.

**Duration:** 11/2002 - 5/2003 (phase 1) and 11/2003 - 04/2004 (phase 2)

**Personal Role:** in phase 1 developing the real-time GPU based rendering pipeline. In phase 2, designing and implementing new LOD paradigms as well as improving the rendering engine performance.

**Details:** We introduced the concept of a transformation-invariant covariance matrix of a set of points which can efficiently be used to determine splat sizes in a multiresolution point hierarchy. We also analyzed continuous point interpolation in object-space, and we defined a new class of parametrized blending kernels as well as a normalization procedure to achieve smooth blending. Furthermore, we proposed a GPU accelerated rendering algorithm based on texture mapping and blending as well as programmable vertex- and pixel-shaders to achieve interactive framerates.

## 3D Modeling From Images and Video Streams
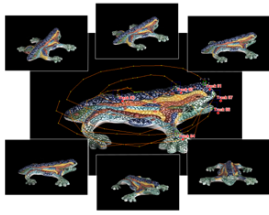
**Description:** The goal of the proposed research project is to develop a software tool, based on image based modeling techniques from video sequences, which will allow the automatic construction of real world objects.

**Duration:** 09/1999 - 06/2003.

**Personal Role:** This project is the main research of my doctoral degree. I designed and developed the complete acquisition, modeling and rendering pipelines.

**Details:** Besides new techniques for image camera calibration I also defined new ways of shape representation that are both adequate for the reconstruction process and can achieve high photorealism, such as point based models or image based models. I also developed new approaches for real-time rendering algorithms of the reconstructed models, exploiting the hardware acceleration on today's videocards.

## Depth-Image Meshing and Warping
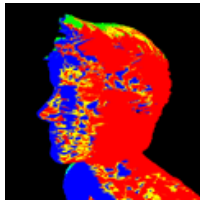
**Description:** In this project we developed a novel and efficient depth-image representation and warping technique based on a piece-wise linear approximation of the depth-image as a textured and simplified triangle mesh.

**Duration:** 09/2002 - 06/2003.

**Personal Role:** Developing the rendering engine for the image based objects using GPU acceleration and programmability. Participation on the design of applications using the DMesh technology.

**Details:** We describe the application of a hierarchical triangulation method to generate view-dependent triangulated depth-meshes efficiently from reference depth-images, and propose a new hardware accelerated depth-image rendering technique that supports per-pixel weighted blending of multiple depth-images in real-time. Applications of our technique include image-based object representations and the use of depth-images in large scale walk-through visualization systems.

## JERICHO: Browsers Embedded in 3D Multi-user Environments

**Description:** The objective of the Jericho project was to provide users the full functionality or their personal computers from within a multi-user 3D environment like those found in computer games.

**Duration:** 01/2001 - 09/2001.

**Personal Role:** Developing new extensions to the game engine to support high quality texture mapping and more articulated characters. Directing the character animation team to generate new character types for the engine.

**Details:** The prototype developed demonstrates the *Displays* window graphical user interface, embedded in a 3D game. The prototype provides Web browser, graphics, game, accessory and other applications that work simultaneously with on going game action. We highly modified and improved the graphical and networking modules of ID Software's Quake[tm] game engine to integrate our GUI functionality within the 3D virtual environment of the game. Currently the system has been copyrighted by the researchers of University of California, Irvine.

## Dark Frost: A computer game engine



**Description:** This team project was a test-bed for developing a complete 3D first person perspective game engine including network modules and protocols for multiplayer capabilities.

**Duration:** 04/2000 - 06/2000.

**Personal Role:** Lead programmer of the graphical engine, collision detection, character animation and level design. Participation in network protocol design.

**Details:** The 3D engine was based in portal culling and was optimally implemented in OpenGL to obtain high frame rates. A collision detection module was built to allow interaction of multiple players with the environment and a complete networking protocol was built to minimize the bandwidth maximizing playability. Character modeling and animation was also included to provide avatars for the players. The final complete was a success and allowed to learn and improve some of the actual techniques used in real 3D games.

## VR Harbor crane simulator

**Description:** This project consisted on developing computer graphics special effects to improve the visual quality on a VR harbor crane simulator constructed by our industrial partner.

**Duration:** 03/1998 - 09/1998

**Personal Role:** Designing the optimized solutions and developing the API's for the industrial partner for effects such as: rain, bulk material (sand and grain piles), physically realistic non-rigid cables and animated characters.

**Details:** The system was developed using Silicon Graphics platforms and the Performer real time animation libraries. Several modules where designed and implemented to simulate realistically (1) non-rigid cables such as the ones on the cranes, (2) bulk material loaded and unloaded from the ships, (3) animated characters ("bots") working on the docks and atmospheric effects such as rain. The main constraints were implementation time and computation cost, since the simulator was already running a physics engine and other complex subsystems such as a haptic platform.

## Robot teleprogramming
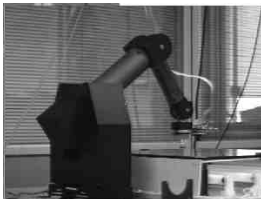


**Description:** This project was a robot teleprogramming application that allowed users to program, simulate and remotely guide a robotic arm via TCP/IP.

**Duration:** during 02/1998

**Personal Role:** Developing the TCP/IP communication protocol for clients to remotely connect to the robot server and developing the client visual feedback system.

**Details:** During the yearly forum of La Salle, School of Engineering several industry partners are invited, and both the university and industry present to the students their main activities of research and production. 1998's subject was the *high speed communications networks*, and the multimedia center, CITeM, showed a robot teleprogramming application. We developed the complete application consisting in the following modules: (1) A robot simulator which allowed the operator to specify complex tasks off-line and send them to the robot. (2) A visual feedback system based in a CODEC (coder/decoder) to send live images over the internet and (3) an observation system allowing a distributed network of clients to receive visual and/or simulated feedback on the task.

## Surgical needles threading machine
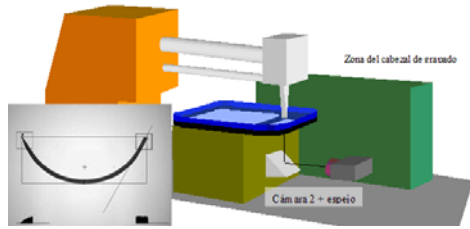


**Description:** The objective of this industry funded project was the design an implementation of a prototype of an automatic threading machine for surgical needles for a medical equipment manufacturer.

**Duration:** 04/1997 - 06/1997 (phase 1) and 09/1997 - 01/1998 (phase 2)

**Personal Role:** during phase 1 (a feasibility study), developing the basic computer vision application to perform the detection and recognition of surgical needles, and developing the communication protocol with the robotic system. During phase 2 implementing the complete API for detection of surgical needles as well as determining position and orientation for commanding the robot.

**Details:** The group at the IRI was hired to develop a computer vision algorithm to feed the threading machine using a robotic arm. The main requirements were processing time and proper manipulation of the needles. An initial feasibility study of different solutions for the threadable needle end recognition problem, and the needle transport from scene to threading dock problem. The second phase was the complete implementation of the final vision algorithms in the real machine. Two cameras were used in conjunction with a back illumination system. Several blob measuring and statistical analysis techniques were been used to locate the needles in the scene and to recognize the threadable end.

## Rock size measurement
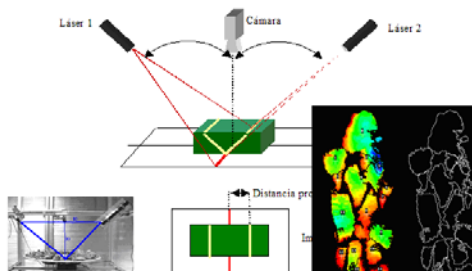


**Description:** The objective of this project was to design and evaluate the feasibility of a prototype to estimate rock size distribution of copper mineral from a conveyor belt feeding up the grinding mills. This project was a European Project initiative partnered with one of top world copper producers.

**Duration:** 01/1997 - 03/1997

**Personal Role:** Designing the acquisition system with linear lasers and a CCD camera. Developing the acquisition algorithms and the high level processing for rock size estimation.

**Details:** In mining industry, the process of mineral extraction requires a very expensive energy-wise grinding process that is severely affected by the rock size distribution in the conveyor belts feeding the mills. The system was based in computer vision and neural networks recognition techniques of range images obtained using a in-house dual laser system.