The 9th World Multi-Conference on Systemics, Cybernetics and Informatics

July 10-13, 2005 - Orlando, Florida, USA

About the Conference

ISAS Conferences started in Baden-Baden, Germany, in 1995, from then on, they have grown from 55 papers to 2904 papers in Orlando WMSCI 2004. Nowadays, the conference has become an international forum where researchers and practitioners examine Systemics, Cybernetics and Informatics key issues. Participants from academies, governments, and industries share ideas and experiences among different disciplines.

Collocated Conferences

Related Conferences

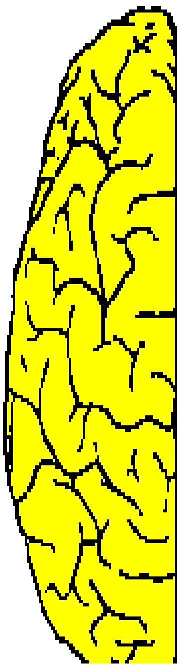
With regards to the bogus papers submitted to WMSCI 2005

Purpose

The purpose of WMSCI 2005 is to promote discussion and interaction between researchers and practitioners focused on disciplines as well as different areas. We are particularly interested in fostering the exchange of concepts, prototypes, research ideas, and other results which could contribute to the academic arena and also benefit business and the industrial community. Read further to learn more about WMSCI 2005 purpose and objectives.

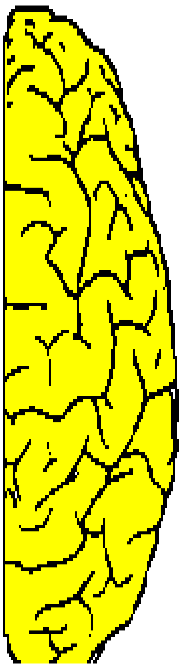
What is WMSCI 2005?

WMSCI 2005 is an international forum for scientists and engineers, researchers and, consultants, theoreticians and practitioners in the fields of Systemics, Cybernetics and Informatics. It is a forum for focusing into specific disciplinary research, as well as for multi, inter and trans-disciplinary studies and projects. One of its aims is to relate disciplines fostering analogical thinking and, hence, producing input to the logical thinking.



A Metaphor

Through WMSCI conferences, we are trying to relate the **analytic** thinking required in **focused** conference sessions, to the **synthetic** thinking, required for analogies generation, which calls for **multi-focus** domain and **divergent** thinking. We are trying to promote a synergic relation between analytically and synthetically oriented minds, as it is found between left and right brain hemispheres, by means of the *corpus callosum*. Then, WMSCI 2005 might be



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perceived as a **research *corpus callosum***, trying to bridge analytically with synthetically oriented efforts, convergent with divergent thinkers and focused specialists with non-focused or multi-focused generalists

Why WMSCI 2005?

There are many good **focused** conferences in any of the major themes of the conference. There are even very good conferences in more **specific** areas included in the major themes of WMSCI 2005. There are also good **general** conferences, which have a wider scope and are more comprehensive. Each one of these kinds of conferences has its typical audience. WMSCI 2005 will bring together both kinds of audiences, so participants, with a focused research, will be able to:

1. Present their focused research in a specific area for scholars/researchers **specialized** in their paper's discipline and, perhaps, for specialists from other **related disciplines** and for **generalists** with a more comprehensive intellectual outlook.

2. Get feedback from researchers with the same specific background, as it is usual in the focused conferences.

3. Get possible feedback from scholars/researchers in related disciplines, thereby opening the possibility of **analogies generation**, **new applications** to/from different knowledge, business and industrial areas, and possibly **new models** for re-thinking anew some of their research problems.

4. Organize sessions where papers from related areas are presented, in order to increase the probability of getting the benefit mentioned in (3).

5. Attract speakers with a wider intellectual interest in order to get a more **comprehensive** conceptual framework and to give **context** to their research effort.

This would allow specialists and focused researchers, to see the forest besides the tree of their discipline and to be aware about the neighboring trees.

WMSCI 2005 participants, with non-focused, non-just-focused or multi-focused research or with a comprehensive intellectual, industrial or business interest, will be able to:

1. Present their research, ideas, reflections, new concepts/designs or industrial/business innovations to a similar or a specialized audience, so suggestion about

possible **improvements** could emerge and possibly new research or development projects.

2. Present ideas requiring multi-disciplinary efforts to be researched or developed in action-research programs.

3. Constitute **international, multi- and/or inter-disciplinary teams** or workgroups in order to conduct research requiring synergic relationships among different kinds of talents, cognitive styles, intellectual faculties and/or research/industrial interests.

4. Create new research areas, based on both: a general framework and various disciplines or focused research areas. This could be done by means of international research teamwork and/or by the elaboration and edition of a multiple-authors book in the Newly Created Field. The newly created Informing Sciences Field is one example on this issue. Our past conferences served to support the initial efforts of their proponents, and now the group has its own yearly conference, newsletter, etc.

Invited Sessions can be organized in a specific or a general theme. These Invited Sessions might grow to Focus Symposia, workshops, satellite events, micro-conferences or even conferences by their own in the context of WMSCI or as independent associated spin offs from WMSCI. At least two independent yearly conferences and two associated conferences are actually spin offs from WMSCI conferences.

Invited Sessions with high quality papers might be selected for multiple-authors book publications. Two books were published recently as a result of good invited sessions, and several others are being considered for publications.

Acceptance decisions related to submitted papers will be based on their respective content review and/or on the respective author's CV. Invited papers will not be reviewed and their acceptance decision will be based on the topic and the respective author's CV.

True Bi-Manual User Interface for Free-Form Surfaces Modeling

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ABSTRACT

This work is devoted to introduce a new Bi-manual system that provides an handful user interface for free-form surface modeling. The Bi-Manual user interface (Bi-Manual-UI) has been realized exploiting a 6DOF (degree-of-freedom) motion controller.
The system considers the integration of a motion controller with a pen based graphical tablet. The Bi-Manual-UI aims to increase the interaction with users enhancing the creation of complex shapes. A sketching plane is available to users who can control its 3D position by the motion controller. In the meanwhile, users can draw a section curve on the plane, using the pen tablet. Moving the plane into a 3D space, the set of created curves area used to generate interactively the free-form surface. Unlikely standard CAD systems, the developed framework enables to change the sectional curve in real-time leading to the creation of shapes with different sections.
Advantages introduced by this innovative instrument consist in the usage of it as a true geometric modelling tool and not only in order to move and rotate virtual camera.

Keywords: 6DOF (degree of freedom), bi-manual interaction, free-form surface modelling, computer-aided design, user interface.

1. INTRODUCTION

Modern Computer-Aided Design (CAD) systems are competing on providing different kinds of tools that enable designers to create complex shapes. CAD tools for free-form modelling require designers to specify several input before obtaining the final shape.
Users visual attention is usually more focused on completing the definition of geometric constraints while a more attention on the shape modelling is desirable.
Moreover, complex users interfaces reduce the visibility space available on the screen [10] (fig. 1).

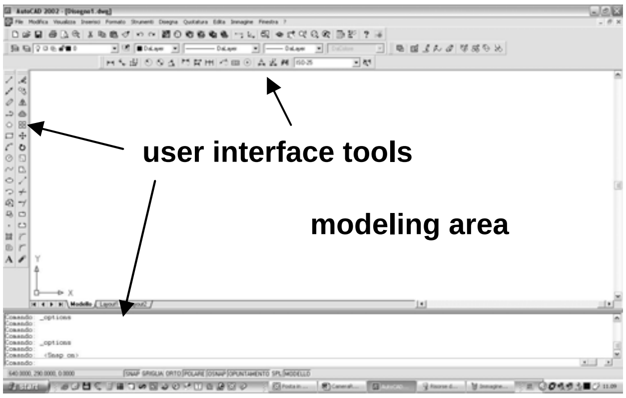

Fig. 1: a typical CAD user interface. The modelling area is reduced by the user interface tools on the border.

Researchers in Human Computer Interaction (HCI) focus their attention in creating user-interface instruments that allow designers to interact with computer systems in a more natural way. One of the first studies [2] classifies human manual labor based on the performance of left and right hand. This classification leads to consider hands movements and gestures as a useful instrument to interact with computers.
Several proposals have been produced in literature: Cutler et al. in [1] considers the bi-manual interaction on a responsive workbench to move 3D objects without considering object design. An application of bi-manual interaction to the product design process has been proposed in [4] and where hands gestures support users activity in the designing. The disadvantage of this approach is due to users have different styles to express the meaning of gestures, causing a misunderstanding by the computer system. In [6] a bi-manual interactive system is proposed to create 3D curves. In this work, curves are generated with the digital tape drawing technique that allows to create 3D complex shapes. The major drawback is that users has to position the virtual point-of-view in an orthogonal position respect to the sketch plane.
In this recent years, several hardware systems devoted to enhance user interaction have been produced. Different kind of instruments like graphical pen tablets and motion controllers are now integrated in most of the commercial and non-commercial CAD systems. Their effectiveness is widely proven but it is still limited. Considering the motion controller system (fig. 1-left), its application in CAD systems is restricted to simple virtual camera movements with no advantages in geometric modelling.
In this work, we introduce to a new Bi-Manual user interface (Bi-UI) for free-form modelling by the mutual integration of a motion controller and a graphical pen tablet. The 6 degree-of-freedom (DOF) related to the motion controller [12] enable to create complex shapes in a free-form design context. Pen tablet allows also to modify the 3D object changing its shape interactively.
The Bi-UI supports designers in the free-form surface modelling because they can be focused on the creation of shapes against to the definition of numerous geometric constrains that modern CAD systems usually require.
Moreover, Bi-UI introduces a new interpretation two-handed user interface that is usually devoted to manipulate objects only with translation, scaling or rotation operations, but not in active modelling actions.
The remainder of this work is organized as follow: section 2 presents the hardware and software architectures, section 3 introduces to the bi-manual free-form surface modelling, concluding with section 4 with some remarks.

2. The Bi-manual-UI ARCHITECTURE

This section describes the hardware and software architecture of the bi-manual framework. The novel integration between the hardware and the developed software has been designed with the aim to enhance the interaction with users and to make the creation of surfaces simpler.

Hardware Architecture

Computer-aided design systems are beginning to consider the integration with new hardware technologies which can enhance and simplify the interaction with designers. Bi-UI integrates together a classic graphical pen tablet and a new kind of user input technology: the motion controller.

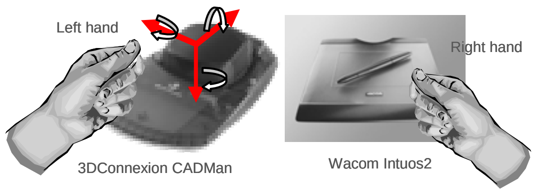

Fig. 2: Hardware architecture: 6DOF motion controller (left); graphical pen tablet(right).

Standard input devices like mouse, keyboard and the pen tablet are limited because only 2 degree-of-freedom movements are allowed. The motion controller has 6 degree-of-freedom. This property enables to design an improved user-interface instrument. Usually, in a computer-aided design environment, the motion controller is programmed to move the virtual camera movement. Pan, zoom, rolling and rotation are mapped on one of the six DOF that the controller allows.
This new approach starts from the idea that 6DOF of the motion controller may be effectively used in real-time creation of a free-form surface. As commonly known way to do a such surface starts from the sketch of a network of 2D curves Cs on several 3D sketching planes Sπ. The surface is then created following a pre-defined direction that, usually, cannot be changed interactively. On the contrary, the Bi-UI links the plane Sπ to the direction defined by 3D operator's hand movements, captured by the motion controller. In this way, users are allowed to define, on the sketch plane, several section Spline [17] curves Cs. Cs is then positioned in the 3D space following the input provided by the motion controller.
Thus the surface is generated in real time and users can control its shape through the Sπ position and by the pen tablet. The pen tablet allows to create and modify interactively the Cs shape. This leads to a Bi-manual interaction with a surface that can change section dynamically.

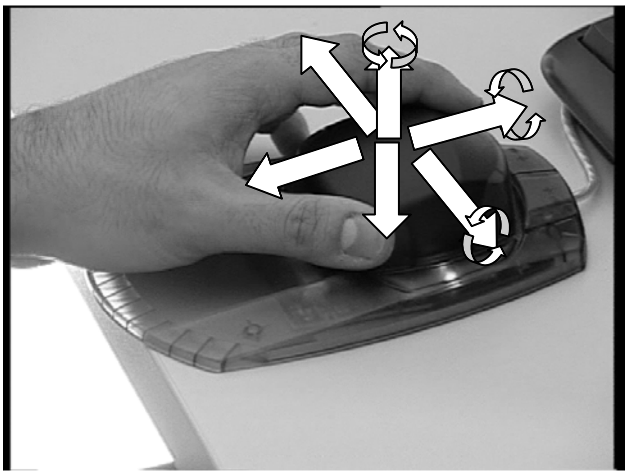

Fig. 3: 6 degree of freedom motion controller by 3D connection©[13].

Software Architecture

The Bi-Manual-UI software framework (Fig. 4) joins together different software libraries for different tasks. Bi-manual-UI provides a very simple user interface that allows designers to create free-form shapes quickly.
The developed software has different topics to cover: it has to manage the actions associated to the motion controller and graphical tablet input; it must support a geometric kernel for shapes representation; designers have to interact with a simple and clear interface.
In order to create a simple graphical user interface (GUI), being able to provide basic actions to start a free-form modelling, we considered the Trolltech QT libraries[16]. Main advantages related to these libraries concern that they are simple to program, they are fully portable on both Windows and Unix-like platforms and they provide a set of class libraries suitable to be linked to different 3D visualization libraries.
The visualization libraries are Open Inventor [15], a scene-graph based libraries provided by TGS. These libraries can be embedded in a QT user interface, quickly. They supply common visualization operations and support a stereoscopic visualization and real-time rendering.
The geometric kernel embeds the ACIS libraries [13], which are widely employed in many commercial Computer-Aided Design systems. ACIS provides a complete geometric support to NURBS (Non-Uniform Rational B-Spline)[17] curves and surfaces representation, boolean operations and geometric check system.
The geometric engine and the visualization kernel (OIV - Open Inventor) have been integrated through an optimized mesh manager routine and a double geometrical database: ACIS (with complex geometric entities) and OIV scene graph (with simple triangulated entities)(Fig. 4).

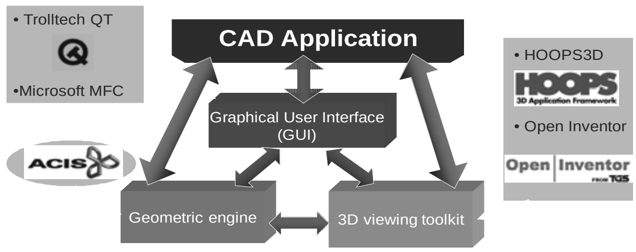

Fig. 4: BI-manual Software architecture.

3. SURFACE MODELLING

In this section we introduce to the bi-manual modelling pipeline which allows designers to create free-form surfaces with different shapes.
The basic idea of Bi-manual UI is providing a friendly approach in creating surfaces focusing designers attention on the modelling steps.
The main tool that users can manage is a sketch plane Sπ (Fig. 5) on which designers can model a sectional curve Cs which define a starting surfaces section.

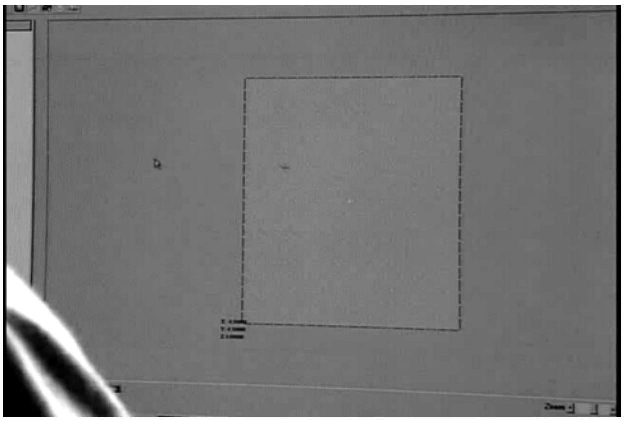

Fig. 5: The sketch plane Sπ which position is controlled by the 6DOF motion controller.

The section plane provides visual information that help users to orient and place it in the 3D space.
Once the sketch plane has been placed (Fig. 9.1), users can model a sectional curve by the graphic tablet. The plane also represents the space domain onto which a Spline curve can be defined (Fig. 6). Designers can place Spline control points on the plane according to the pen tablet position that is managed by one hand.

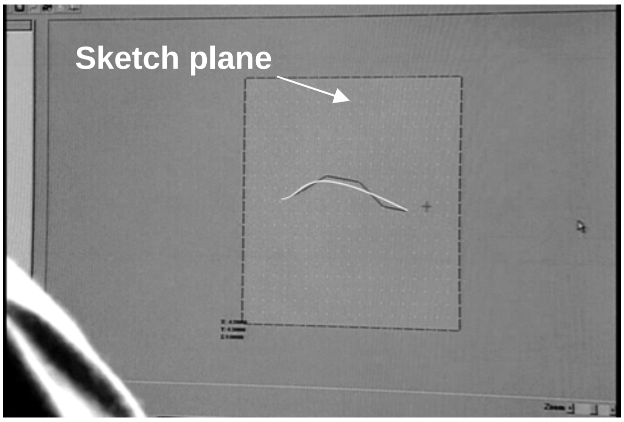

Fig. 6: Section curve spline modeled on the sketch plane. It represents the beginning surface profile modeled moving the plane in the 3D space.

Once the profile has been defined, designers are allowed to shift the plane and rotate it by the motion controller.
The 6DOF controller is synchronized with the sketch plane position and users can move and orient it quickly. The system monitors the sketch plane and section curve position. Users can then set the Cs's position enabling the geometric kernel to build the surface.
Several section curves can be then positioned in the 3D space and the geometric kernel can create the final surface in real time. In this way users are able to define a sequence of N section curves and the kernel can create the appropriate shape. Moreover, the kernel monitors possible errors that can occur during the designing, for example it avoids from the presence of self intersections or non-continuity.
To represent the surface mathematically, the geometric kernel is configured to use the NURBS (Non Uniform Rational B-Spline) representation as it is the most implemented mathematical description used in commercial and non commercial CAD frameworks.

In general a NURBS surfaces S(u,v) is defined as:

$$S(u,v) = \sum_{i=1}^{m} \sum_{j=1}^{n} p_{i,j} R_{i,m;j,n}(u,v) \quad (1)$$

where

$$R_{i,m;j,n}(u,v) = \frac{w_{i,j} N_{i,n}(u) N_{j,m}(v)}{\sum_{i=1}^{m} \sum_{j=1}^{n} w_{i,j} N_{i,m}(u) N_{j,n}(v)} \quad (2)$$

The matrix $\mathbf{P} = \{p_{i,j}\}$ represents the control points grid which defines the NURBS surface generated by the tensor product of rational B-Spline $R_{i,m;j,n}(u,v)$.
The geometric engine considers for each section curve its control points and, step by step, it creates the surface control point grid interactively. The final shape is then created in real time through iterated skinning operations[17] (Fig. 7 and Fig. 9.4).
While the motion controller enables to position the set of section curves in the space, the pen tablet allows designer to change the section curve profile. Once the user has selected a section curve Cs, he is able to change the profile both adding or removing a control point from the control point polygon. The insertion/removal of a control point has been realized through the standard knot-insertion and knot-removal operations [17].
In this way the geometric kernel is able to update the overall surface shape in real-time and users can quickly change shapes.

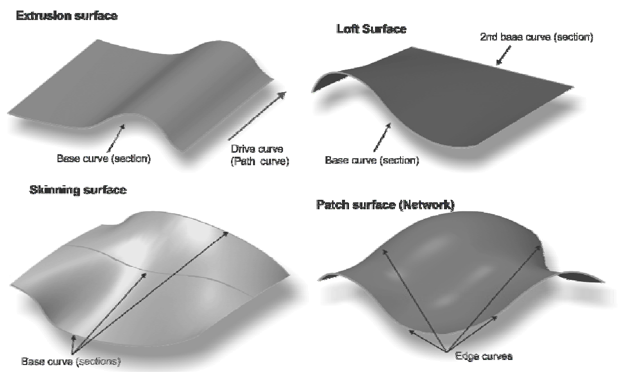

Fig. 7: standard operation for creating surfaces: (top-left) extrusion; (top-right) lofting; (bottom-left) skinning; (bottom-right) network.

Immersive Visualization

The Bi-manual system is also enhanced with a stereoscopic visualization. The immersive visualization has been realized using active liquid crystal displays (LCD) glasses. The glasses are synchronized by an emitter positioned in front of the user. The emitter regulates the lens flickering in according with the supported graphics card. In our work we considered 3D wildcats graphics card by 3DLabs.
The immersive visualization (Fig. 8) provides the operator of a more captivating and immersive feeling during designing session and makes him able to better evaluate shapes and volumes.

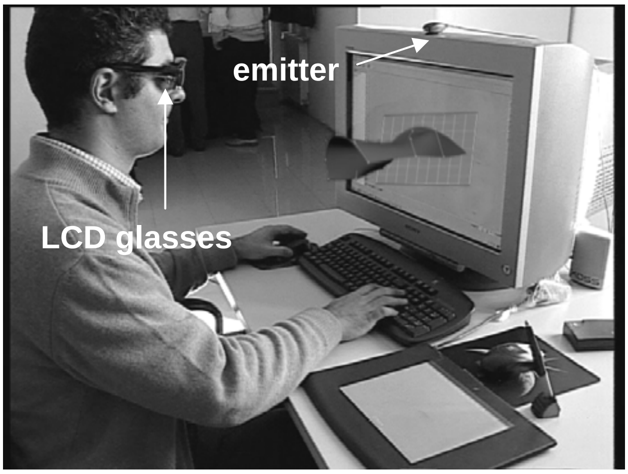

Fig. 8: Active stereoscopic vision for immersive visualization and interaction.

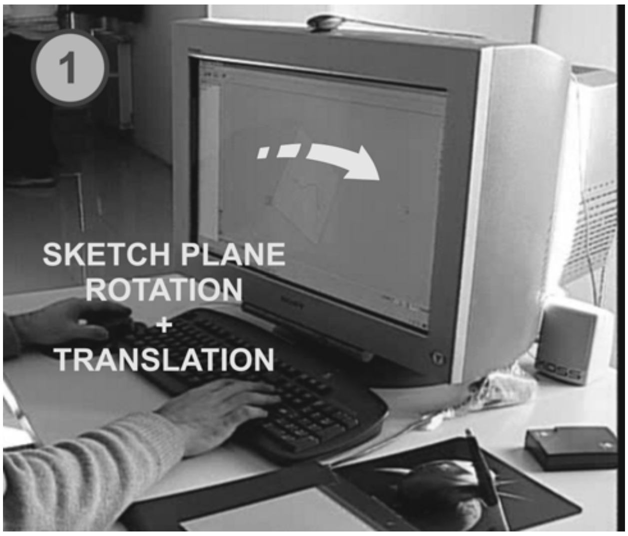

Fig. 9. Shape modelling: 1 – 6DOF sketch plane; 2 – Sketch plane positioning and orientation in the 3D space; 3 – First and 2nd section curve are joined together; 4 – N section curves are joined to create the final NURBS surface.

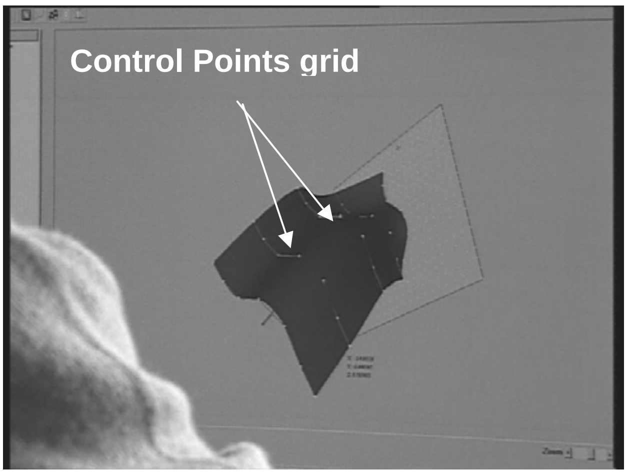

Fig. 10: NURBS surface with its control points grid.

4. CONCLUSIONS

In this work we introduced a novel Bi-manual interface based on the integration of new hardware technologies with modern software solutions for the 3D geometric modelling and visualization. The aim of the presented work is to create a new way to make free-form modelling easier than the standard CAD systems on the market.
The major advantage is the fact that users can interact with the geometric modelling system using a bi-manual approach. In this manner, designers are more focused on the modelling aspects. On the contrary, modern CAD systems require several inputs constraints to create the final shape.
The hardware technologies employed in this work are a 6 degree-of-freedom motion controller and a graphical pen tablet. The motion controller improves the degree of freedom in designing and enables to create very complex, but more appealed shapes, supported also by the graphical pen tablet that allows to quickly modify section curves and then the entire shape.
The Bi-manual user interface allows designers to create shapes easier and quickly because it provides a visual natural feedback that is useful to orient and create the shape in the 3D space. Moreover, a stereoscopic visualization is a new add-in not yet supported or exploited by the commercial CAD frameworks.
The core system has been programmed building C++ classes that integrate together object oriented libraries devoted to the visualization (Open Inventor), to the geometric representation (ACIS) and manages the hardware interactions.

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