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New Approaches to 3D Gestural Modeling - the 3D SketchMaker Project

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The 3D SketchMaker project has developed two prototypes for a gestural 3D sketching system to be used in the earliest phases of the design process. The goal of this ongoing research is to provide architects, and other designers involved in object conception, with a 3D gestural instrument that takes advantage of new virtual reality resources and is more natural than using the mouse, less difficult than learning complex software and less abstract than manipulating 2D entities on orthogonal projections.
The system was conceived to assist or replace the first 2D drawing steps in the design process, generating rough 3D sketches that can be refined later using any 3D package. It is, in essence, a 3D modeling system directed to do sketching with hand movements and gestures in a virtual reality environment.
***Keywords**: Gestural interface; virtual reality; 3D modeling; sketching;*

A short introduction

Sketching is the means that architects, designers, artists and sculptors use to represent, visualise and study their concepts of three-dimensional objects. Traditionally sketching has been done with pencils and paper, resulting in a set of two-dimensional drawings representing three-dimensional objects. The current process of design is, usually, a sequence of 2D hand sketching, 2D computer drafting, 3D modeling, and finally, rendering. Usually this process involves two or more different professionals: one to sketch the concepts and others to translate these sketches into cad drawings and later to generate and to render a 3D model.

As a result, there is a gap between the first design sketches and the remaining design process (Brown, 1995). Architects and other designers are missing the potential of developing their ideas directly using the same tools that will be used later for the rest of the project's development and representation. Also they are missing the opportunity, resources and benefits of using virtual reality and 3D computer models from the very inception of the design process (Jacobs, 1991).

For many architects and designers, one of the main reasons for not using 3D modeling or even computers from the very beginning of the design process is that both current hardware and software are hardly appropriate to do the spontaneous and quick drawings that are used to assist in conceptualizing their objects.

Three-dimensional modeling packages, for example, use two-and-three dimension elements, in a three-dimensional environment, but usually employ the paper-and-pencil metaphor or its pointing tools, through the pointer of the mouse. These kinds of interface and 2D input devices, such as mice or pen-and-tablets are not appropriate to work in 3D environments. Pointing devices and menus in 2D and 3D software do not allow the freedom, quickness and spontaneity needed to establish a "continuous cycling of information from paper to eye to brain to hand and back to paper" (Laseau, 1988) as hand sketching does.

The focus of this project is on the input interface. The goal is the development of an easy and intuitive 3D sketching gestural interface and system that is more natural than using the mouse, less difficult than learning complex software and less abstract than manipulating 2D entities on orthogonal projections.

One of the assumptions basic to achieving this goal is that the mouse 2D movements should be translated into 3D spatial movements, i.e., hand movements and gestures, considering that "the obvious fact that people have found two hands useful, even essential, in daily life has been ignored by the user-interface community, including those working with reality goggles." (Krueger, 1991)

It is known that "spontaneous (that is, unplanned, unselfconscious) gesture accompanies speech in most communicative situations, and in most cultures..." (Cassel, 1998). Hand gestures are used in a variety of ways in association with spoken language to emphasise the speech, to give clues, to enhance the communication, etc. Thus, according to Cassel (1998), "...if our goal is to get away from learned, pre-defined interaction techniques and create natural interfaces for normal human users, we should concentrate on the type of gestures that come naturally to normal humans."

Among the common spontaneous gestures described by Mcneill (1992), the iconic are gestures depicting a concrete object or event and bearing a close formal relationship to the semantic content of the speech. Iconic gestures are representational and descriptive. Considering that most people use iconic gesture as an aid to language when trying to describe the shape or form of objects (fig.1), it could be said that gestures are a natural way of "sketching" in the human three-dimensional environment.

The 3D SketchMaker was conceived to take advantage of this natural tendency and to assist or replace the first 2D drawing steps in the design process, generating rough 3D sketches that can be refined later using any 3D package. It is, in essence, a 3D modeling system directed to do sketching with hand movements and gestures in a virtual reality environment.

Related work

Previous work in 3D gestural interface include both gesture analysis and recognition that can be used to perform specific tasks as well as three-dimensional modeling using hands movements and some input device.

Example applications in the first group include Myron Krueger's VideoDESK (1991) and gesture recognition used in conjunction with American Deaf Language.

Applications in the second group include several works, which use different techniques to create three-dimensional forms: Hirikoshi (1994), Zeleznik (1995), Akeo (1994), Pugh (1992) and Branco (1994) have proposed methods to create three-dimensional forms from two dimensions sketches; Deering (1995), Sachs (1991), Galyean (1991) or Butterworth (1992)

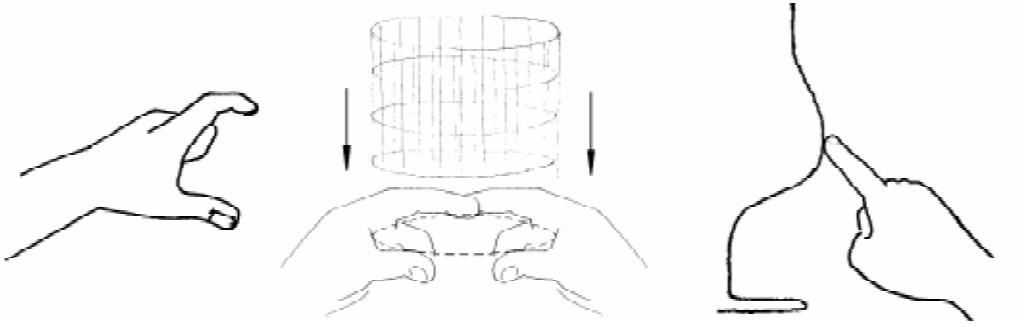
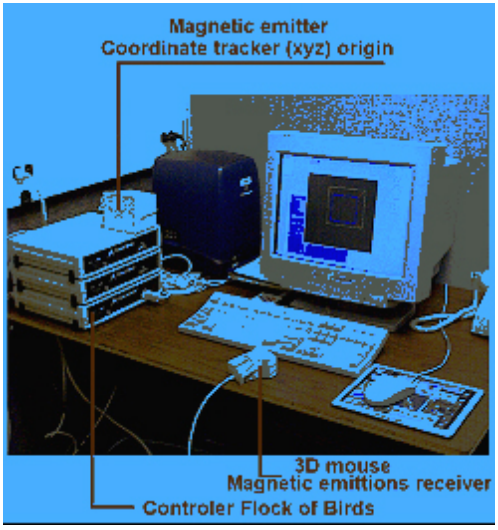


Figure 1. Iconic gestures are frequently used to help language in the description of the form and shape of objects



proposed tools to create three-dimensional objects; Yoshida (1996) and Shaw (1997) begin with a 3D object that is modified by finger and hand movements.

A more recent example is Nishino's (1998) technique that repeats the making process of a complex 3D object in the real world: preparation of some primitive shapes, combination of these primitives to form a rough shape and deformation of this rough shape to make a finer one.

Our work will use some of these techniques with the main difference being that we want to be able to create rough free-form surfaces with hand movements while being simultaneously able to deform them with the real, spatial, multisensorial 3D input of a data glove.

The first results: The 3D SketchMaker prototype

We intend the final 3D SketchMaker product to be a virtual-reality, 3D-modeling system for computer generation and manipulation, with hand movements and gestures, of quick and rough computer 3D solids or surfaces.

As we wanted, at the end, to be able to simulate clay modeling, the choice was the use of true three-dimensional input instead of a 2D input technique like Krueger's Videotouch (Krueger, 1991).

The first product from this project is a prototype of a desktop VR surface modeler that allows surface description with two simple hands movements. The basis of this prototype is a sensor that returns its xyz position (a tracker), as well as its three orientation angles, azimuth, elevation and roll, to the application and a piece of software that collects and processes the data. For this prototype we have used a 3D mouse and the hardware of Ascension's Flock of Birds tracker with a Silicon Graphics workstation (fig.2).

Two crossing spatial lines describe the surface: one, a path, and the other, a profile that is extruded

Figure 2. The tracker has a sensor (inside a mouse box) which receives the magnetic emission of another box, the tracker's coordinate origin. The sensor's spatial position is sent to the controller in 144 Hz, i.e, 144 times per second. This position information is then transformed by the software in graphic form. In this case, the software draws lines with the movements of the receiver.

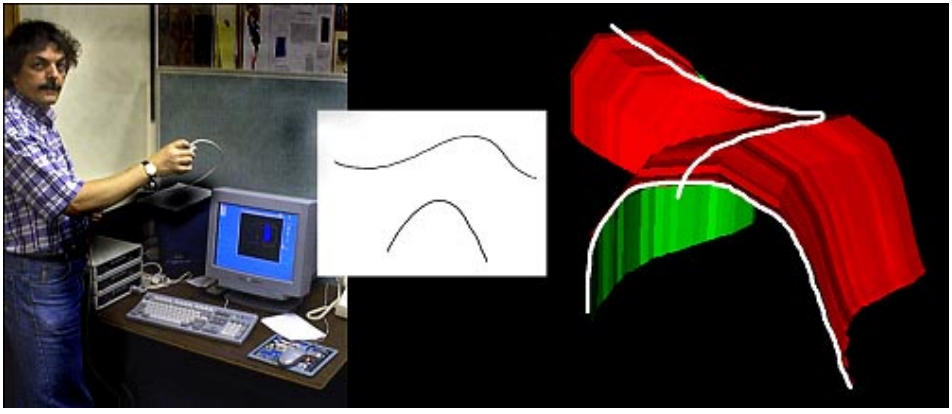


Figure 3. The shape of a surface can be defined with a hand movement in the space, instead of tracing a line in the xy, xz or yz windows of a normal CAD or 3D package. Here, a line is not necessarily on a plane; it can be an actual spatial line.Like any sketches, these 3D computer-generated models are rough representations of the objects, which will need later treatment and refinement.

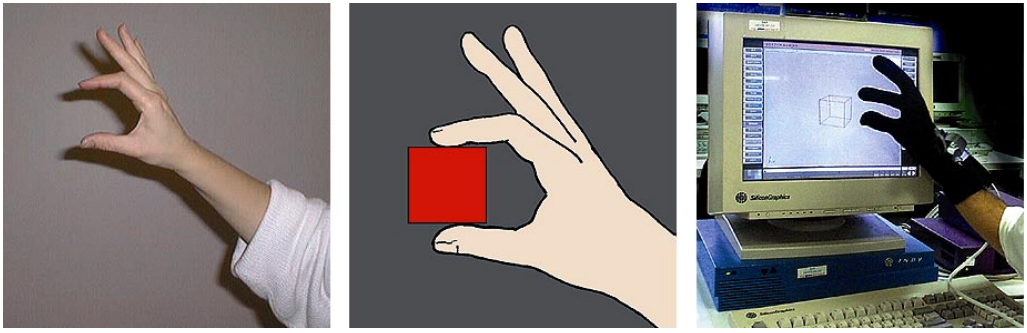


Figure 4.The recognition of hand formations allows the designer to generate the more common basic primitives: cube, sphere, cylinder and cone, as well as to grab, manipulate and do Boolean operations.

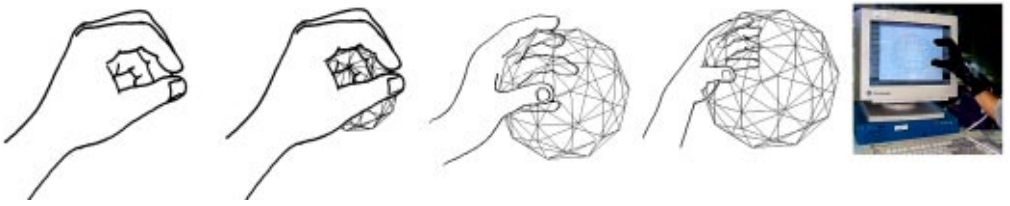


Figure 5.The hand formation is recognized by the system and a solid is associated to it, as if the user were holding the object. Once virtually grabbed, this object can be positioned with one hand movement, or scaled just with the aperture of the fingers, i.e., if the fingers are brought closer to each other, the model is scaled down, if the hand is opened, the model is enlarged.

along the path (fig.3). While the user moves the hand with the 3D mouse (or any spatial sensor), the system acquires the data in three degrees of freedom, constructs and renders the surface.

The next step: gesture recognition

A second prototype has been developed to be used in association with the surface modeler in cases where the model has a basic regular shape, and to enable manipulation of all models. In this prototype, the input device is an instrumented glove that allows the system to recognise the user's hand formation.

A primitive solid is associated with the hand, as if the user were holding the object. After the solid's creation, designers will be able, using their hands, to grab, position, scale or modify the object with Boolean operations (fig. 4 and 5)

The third prototype: surface generation and deformation

A third prototype is being developed based on an instrumented glove to describe the surfaces, allowing the use of finger movements to produce topographical changes as well as deforming the resulting meshes. This piece supposes the user will be able to create rough free-form surfaces with hand movements while being simultaneously able to deform them with finger movements.

Conclusion

Instead of trying to extract meaning from 2D drawings, or to deform primitive shapes, the 3D SketchMaker is intended to allow direct 3D sketching in real life's 3D environment. Gestures are not used here as a language, but as a way of describing to the computer the form or the boundary surfaces of an object, employing the hand movements and gestures most people use when trying to describe the form or the shape of an object.

The system is still being developed and tested in parts. At this time we don't have exactly a system to evaluate. The pieces worked more like proof-of-concepts and must be put together.

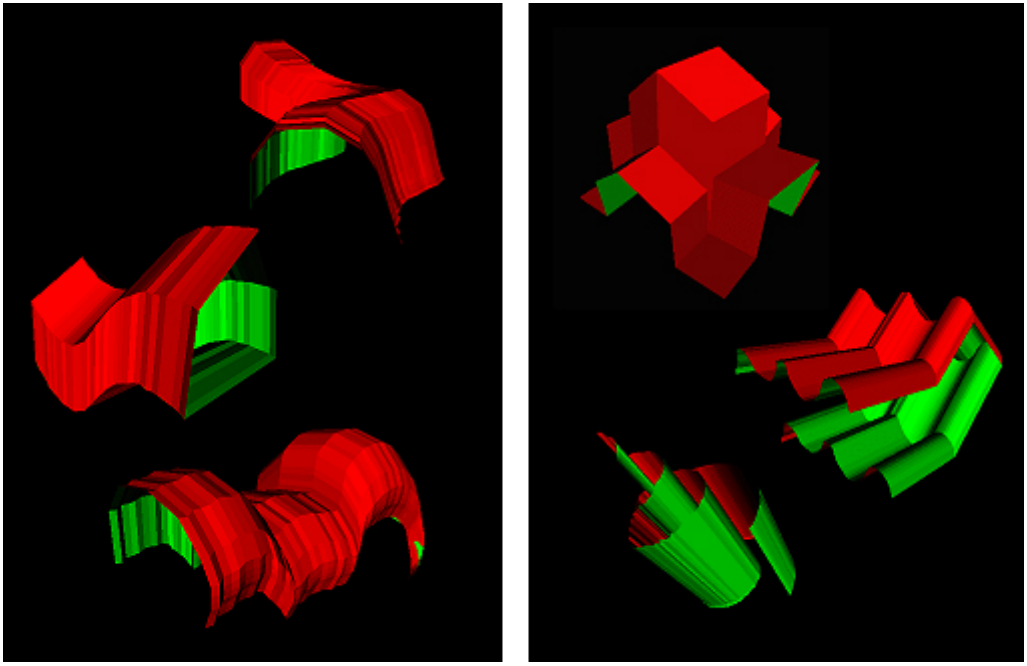


Figure 6.

Further development will include more methods of 3D sketching, clay modeling, sculpting, 3D-visualization devices and other VR features. We are moving toward an easy, intuitive and transparent modeling VR system.

Some 3D gesture-modelled surfaces (fig 6).

These models can be seen as VRML 3D interactive models in the author's web address: www.epratini.hpg.com.br

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