REAL 3D PRO-1000

Professional Series

3D REAL

®

a Lockheed Martin Company

Product Description

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Professional Series

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Version 4.0e

a Lockheed Martin Company

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REAL 3D PRO-1000 Professional Series

PRODUCT OVERVIEW

The PRO-1000 Professional Series is the latest in a family of high-performance image generator products from Real 3D®, a Lockheed Martin Company. With over 200,000 Real 3D architecture-based systems shipped for the entertainment and military marketplace, Lockheed Martin is the recognized leader in delivering volume products to the consumer marketplace. Based on over 30 years of experience in producing high-quality, high-reliability, fully programmable image generator systems, the PRO-1000 incorporates numerous sophisticated features at an extremely low price. Derived from over 40 graphics patents including MIP-mapped tri-linear interpolation texture mapping algorithms, depth buffer, and a new patent-pending S-buffer anti-aliasing technology, the REAL 3D PRO-1000 provides the very best image generation capabilities at an order of magnitude reduction in price from other systems on the market today. Unlike the PRO–1000, most would–be simulation systems available today are designed as engineering workstations. The REAL 3D PRO-1000 was built as an image generator and, therefore, meets the needs of those applications that demand true real-time image generation performance. Compatible with the popular MultiGen® CREATOR modeling system, Gemini Technology's OpenGVS™ real-time system software modules, Datapath's RealiMation, and Sense8's WorldToolKit, the PRO-1000 represents a breakthrough in price performance for simulation and training, location-based entertainment (LBE) and commercial visualization market places. The REAL 3D PRO-1000 interfaces with host computational devices by way of an industry standard high-speed interface, allowing the user to select a host CPU ranging from a PC to a high performance workstation to control real-time operation. This, in turn, brings low-cost industry standard development tools to the real-time processing environment.

At the heart of the PRO–1000 are several new custom Application Specific Integrated Circuits (ASICs) that provide geometry processing of over one million visible polygons per second. Pixel fill rates can exceed 200 million pixels per second. With OpenGVS, RealiMation and WorldToolKit software packages, applications developed for other workstation platforms port easily to the Real 3D product line. For the user, this enables

performance and image quality superior to competitive offerings at a fraction of the cost. The following data describes the standard features incorporated in the REAL 3D PRO-1000 system.

TECHNICAL SUMMARY

The REAL 3D PRO-1000 visual system is a true low-cost, high-performance image generator for serious simulation applications. All image-related computations are performed in the image generator. The PRO-1000 is controlled by a user-supplied personal computer or workstation that acts as host for control programs and as a link to the rest of the simulation system. The PRO–1000 system off-loads intensive floating point computations and all "out-the-window" image management tasks from the host computer to achieve a sustained display update rate of 30 or 60 frames per second. The basic polygon transformation and processing rate is one million per second. Basic pixel fill rate is 50 megapixels per second. Pixel fill rate can be expanded to 100 megapixels per second by simply adding a pixel fill daughter board to the system. A high-resolution model with four pixel boards offers 200 megapixels per second fill rate. This is especially important for high resolution and 60 Hz update requirements, or where high-scene complexity is required. To support the ultimate in image realism, the PRO–1000 provides 8 megabytes (MB) of on-board MIP-mapped texture memory in the base configuration. Texture memory can be expanded to 32 MB by addition of an expansion option. Real 3D's patented MIP-mapped, tri-linear texture interpolation and microtexture algorithms are used to produce visual scenes of incomparable fidelity and realism in the industry today. To provide the ultimate in image clarity and sharpness, the PRO–1000 incorporates anti-aliasing performed as a post process on the final visible pixel data. This patent-pending anti–aliasing algorithm produces superior images at a fraction of the performance penalty and hardware costs associated with subpixel anti–aliasing.

HARDWARE ELEMENTS

The REAL 3D PRO-1000 visual system hardware is composed of three electronic subsystems housed in a single desktop or deskside enclosure. These subsystems segregate the functions of scene processing and have the following capabilities.

The host interface subsystem controls data transfer to and from the simulation host computer by way of a differential fast-wide SCSI II interface. The interface supports a 20 MB per second transfer rate and allows for up to seven PRO-1000 systems to be connected to a single host interface card. Multiple interface cards may be added to the host computer for those applications requiring more than seven devices. Genlock capability is provided in the PRO-1000 to synchronize display updates between separate output channels.

The rendering subsystem incorporates the latest in custom ASIC processors utilizing 0.5 micron technology to perform geometry and display functions. The geometry processor culls the display list, performs all lighting calculations at the geometric level, clips the images to the screen, controls the viewport processing, manages input/output (I/O) over the internal high–speed bus, and transforms the data for presentation to the display subsystem.

The display subsystem completes the lighting calculations, maps full color or monochrome textures to the 3D polygons, transforms 3D space into 2D screen coordinate space, rasterizes the data into pixels, performs hidden surface removal, anti–aliases the final image, and converts it to analog video for output to the display.

SOFTWARE ELEMENTS

Real 3D has developed a powerful, yet intuitive, Application Programming Interface (API) software package for use with PRO-1000 Professional Series systems. The PRO-API software package provides a user-friendly environment for developing high-performance real-time graphics and simulation applications. The PRO-API delivers functionality and control of key baseline functions such as animation sequences, lighting, real-time shading and level-of-detail (LOD). Real 3D's product software provides capability across platforms and supports multiple operating systems including Windows NT® 4.0, Windows NT® 3.5.1, Windows® 95, UNIX®, Solaris®, and IRIX®.

The latest PRO-API delivers a broad array of functionality and ease-of-use features to provide PRO-1000 users with a fully functional toolkit for real-time applications development using C and C++ linkable libraries. Real 3D's new MultiGen Creator™ loader enables the user to load user-authored databases. This enhanced interface exploits the full power of the PRO-1000 Professional Series and delivers real-time design functionality that empowers designers and provides the features they need and want. Electronic and hardcopy documentation is provided with each PRO-1000 system. The on-line documentation includes hot-links, bookmarks, and thumbnails to user selectable topics, enabling programmers to quickly and effectively generate high-quality, high-performance real-time applications.

Key Functions of the PRO-API include:

- Morphed geometry support
- Immediate mode geometry (including polygons, culling and texture)
- Immediate mode animation sequences and switch nodes
- Dynamic database paging (geometry & textures)
- Articulated parts
- Support for point lights
- Shared geometry instancing
- Load management control via PRO-1000 LOD nodes
- Hardware control and feedback

Ease-of-Use Features include:

- Easy manipulation of models and articulated parts
- Full control of animation sequences
- Easy manipulation of multiple viewports and models to simulate 2D overlays
- Readable, easily understood function calls
- Electronic and hardcopy documentation

SYSTEM CONFIGURATIONS

The REAL 3D PRO-1000 series image generator supports multiple configurations. The standard PRO-1000 configurations are listed by model number in Table 1. The system diagram is shown in Figure 1.

The differential fast-wide SCSI II interface connects the PRO–1000 to a host computer. The host computer may be a PC or a workstation.

Table 1. PRO–1000 Professional Series Standard Model Configurations

PRO-1000 Model Number	Pixel Processors	Pixel Writes
1100	1	50M
1200	2	100M
1400	4	200M

ADD 1, 2, OR 4 PIXEL PROCESSOR

(OPTIONAL EXTERNAL GENLOCK)

DIFFERENTIAL
FAST-WIDE
SCSI II BUS

PRO-1000

TO DISPLAY

OPTIONAL
SECOND VIDEO
CHANNEL

**HOST
COMPUTER**

DISPLAY
SYNC

PRO-1000

TO DISPLAY

OPTIONAL
SECOND VIDEO
CHANNEL

ADD AS MANY PRO-1000 IG's
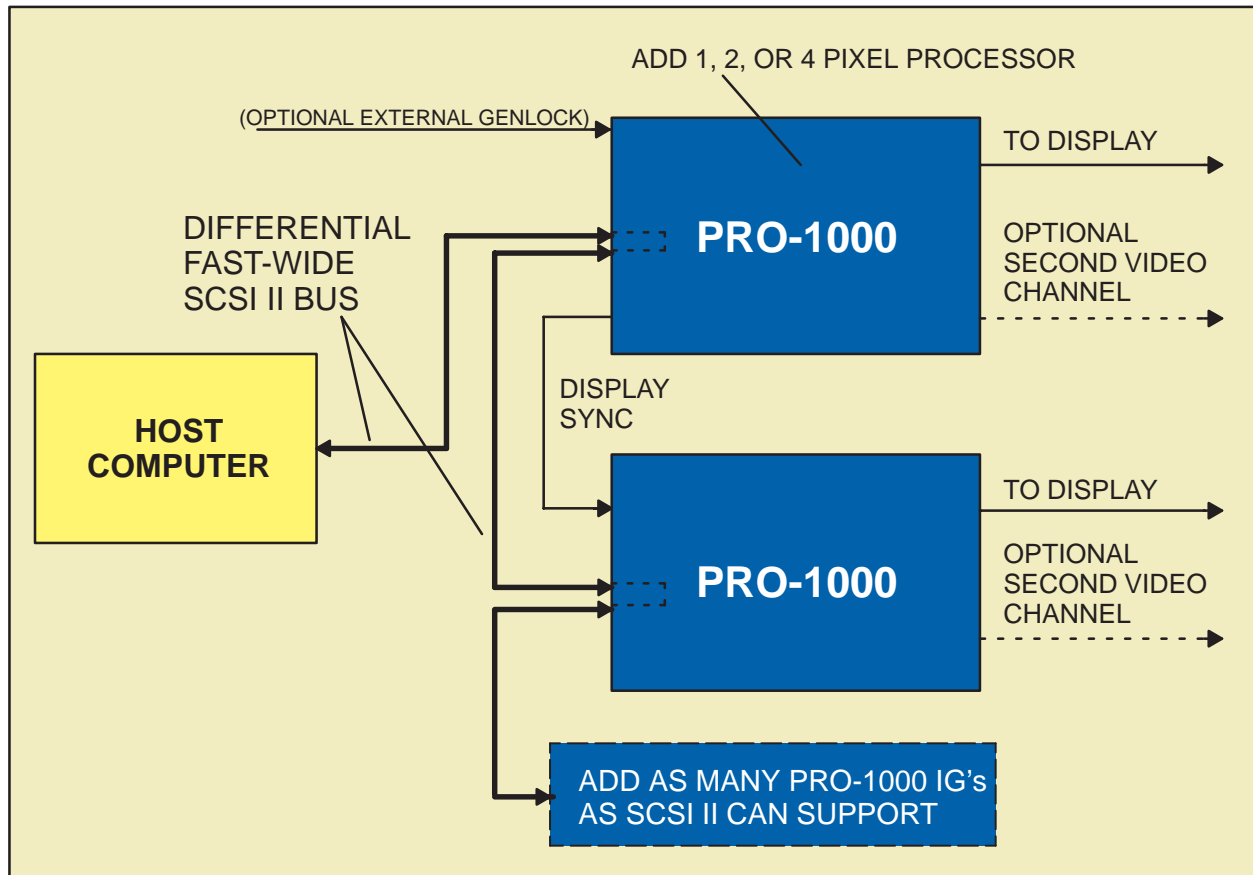AS SCSI II CAN SUPPORT

Figure 1. PRO-1000 Series Image Generator System Diagram

UPDATE RATE AND DISPLAY MODES

DISPLAY RESOLUTION

REAL 3D PRO-1000 can support multiple display resolutions at real-time rates of 30 Hz and 60 Hz. The standard resolutions are shown in Table 2 and Table 3. If multiple REAL 3D PRO-1000 systems are synchronized together, multiple channel systems can be configured. The display parameters are programmable to allow for a variety of projectors and monitors. Contact Real 3D for additional product information. The system supports both interlaced and non-interlaced formats. The digital to analog converters have a resolution of eight bits per red, green, and blue component. Synchronization is negative composite. Model 1400 offers edge blending hardware to support alignment of adjacent display channels.

Table 2. PRO-1000 Image Generator Standard Resolution (Single Channel)

RESOLUTION	INTERLACE	DISPLAY UPDATE RATE (Hz)	MODEL NUMBER
640H X 480V	non-interlace	60	1100/1200/1400
1024H X 768V	non-interlace	60	1400
512H X 486V	interlace	59.94*	1100/1200
720H X 486V	interlace	59.94*	1400
720H X 576V	interlace	50	1400

* Application programmers should treat this as 60 Hz.

The following table shows the standard configurations supported in dual monitor mode. In the dual monitor mode, both monitors must have the same resolution.

Table 3. PRO-1000 Standard Resolutions (Dual Channel)

RESOLUTION	INTERLACE	DISPLAY UPDATE RATE (Hz)	MODEL NUMBER
640H X 480V	non–interlace	60	1400
512H X 486V	interlace	59.94*	1200
640H X 486V	interlace	59.94*	1400

* Application programmers should treat this as 60 Hz.

TRANSPORT DELAY / SYSTEM LATENCY

The transport delay is defined as the amount of time taken to render and display a new view of an image given a new viewing input command, such as a change in position or attitude. The transport delay for the REAL 3D PRO-1000 is 87 milliseconds for a 30 Hz frame update rate and 58 milliseconds for a 60 Hz frame update rate. Additionally, the PRO–1000 is designed with a very high efficiency (97% at 30 Hz) so only 1.23 milliseconds in each update is associated with system overhead. This is defined as the system latency and is the minimum level below which the system cannot function.

GENLOCK DISPLAY SYNCHRONIZATION

The REAL 3D PRO-1000 supports Genlock display synchronization. The PRO-1000 can accept an external Genlock signal and daisy chain that signal to other PRO-1000 systems, or a designated REAL 3D PRO-1000 system can function as a display synchronization master. Genlock is recommended for multiple PRO-1000 configurations to optimize performance. This function must be enabled in software by the host computer.

GEOMETRY PROCESSING

DEFINITION OF THE TERM "POLYGON"

For the PRO–1000, a polygon is a fully rendered, textured, shaded, anti-aliased, fogged, illuminated, translucent, Z-buffered, three or four vertex geometric primitive. This definition of a polygon, however, is quite different from that defined by general purpose graphics systems vendors. It is important to note this difference when comparing performance of various image generation systems.

DATABASE MEMORY

In the basic PRO–1000, 8 MB of polygon memory is provided. With 8 MB of memory, a typical database can include over 100,000 polygons of active database storage. Additional database memory can be added in 8 MB increments by simply adding memory daughter boards up to a total of 32 MB of polygon memory capable of storing over 400,000 polygons. Dynamic database paging is also implemented through version 4.0 of the PRO-API.

GEOMETRY DATA FORMAT

Position and attitude data for the viewing eyepoint and other moving models are sent to the image generator in 32-bit IEEE floating point format. Fixed point formats are also supported, where required, for those applications requiring geocentric databases.

DATABASE TRAVERSAL

The REAL 3D PRO-1000 uses a proprietary algorithm that automatically disregards from geometric traversal those polygons that are excluded from the viewing pyramid. A database consisting of hundreds of thousands of polygons can be loaded into system memory, but the traversal only occurs on that which is visible in the scene. This eliminates a large quantity of unnecessary computational work for processing the image. In addition, the user does not have to know what is visible because REAL 3D PRO-1000 automatically tracks this for each field update. The database traversal also determines the correct LOD for each visible or moving database element.

MATRIX TREE DEPTH

Real-time matrix tree decoding or object nesting is done to a depth of 15. This provides the user with the ability to define and manipulate complex structures in the geometry database.

POLYGONS / SYSTEM

Each REAL 3D PRO-1000 system can process up to 33,000 polygons at 30 Hz or 16,500 polygons at 60 Hz. Polygon capacity for a multi-channel system is dictated by the number of PRO-1000 systems combined to meet all system performance requirements. The number of channels per system is limited only by the host computer SCSI II port configuration. Thus, 33,000 polygons per channel times the number of channels in a system yields the total polygon processing capacity per system.

INSTANCING (UNIVERSAL FEATURES)

Any geometric object may be instanced multiple times, saving valuable storage and enabling very complex application scenarios. Each instanced object may have its own unique color as a dynamic attribute.

TEXTURE

PERSPECTIVE TEXTURE

The PRO–1000 provides texture mapping as an integral function for producing the ultimate in scene realism. Texture mapping is performed with the correct perspective for the viewport settings in all cases to avoid visual anomalies and provide a true representation of the scene.

TEXTURE ANTI-ALIASING

Texture mapping in the PRO–1000 is tri-linearly interpolated to 8 bits of precision per color component using MIP–mapping. This interpolation in x,y and z axes provides smooth image transitions as objects move and eliminates aliasing effects associated with raster displays.

TEXTURE STORAGE

There are four million texture memory locations in the basic PRO–1000. An optional upgrade increases texture storage to 16 million texture memory locations. Each texture memory location is a 16-bit word. Control bits determine how the 16-bit word is interpreted by the hardware. The 16-bit word may contain any combination of 4-bit monochrome texture, 8-bit monochrome texture, 15-bit color (5 bits red, 5 bits green, 5 bits blue, 1-bit translucency (on or off)), or 4 bits red, 4 bits green, 4 bits blue, and 4 bits of translucency.

Texture map size may range from 32 by 32 to 1024 by 1024 texels in increments of powers of 2, i.e. 64 x 128, 256 x 1024 and is defined in rectangular or square format. Microtexture and texture MIP LODs are included in the texel count. Dynamic texture paging is also implemented through version 4.0 of the PRO-API.

TEXTURE TRANSLUCENCY

Translucency may be specified as texture translucency or contour texture. Contour texture defines a texel as totally opaque.

Up to 16 levels of translucency are available. In addition to specifying the intensity or color of the texture, the 16-bit texture word may contain 1 or 4 bits of translucency data.

MIRROR TEXTURE MAPS

The PRO-1000 incorporates a texture mirroring function. When enabled, this function flips the left and right or top and bottom of every other wrap of the texture map. For example, if the texture map contained the left side of a face, two wraps of the map, with mirroring in the horizontal direction would produce a whole face.

MICRO TEXTURE

In order to produce realistic near ground motion cues in visual simulation, high-frequency contrasting textures are required. To prevent the saturation of normal texture memory with these short range patterns, the PRO–1000 provides microtexture storage and processing. Microtexture supplements the texture pattern on a polygon by adding random texture detail to the texture patterns on polygons that are very close to the view point. Four 128 x 128 color maps are reserved for microtexture by default. The host may specify whether to reserve 0, 4, or 8 128 x 128 maps for microtexture.

REPETITIVE TEXTURE

To produce very large terrain or natural environments, generic texture maps are applied across larger polygons. To optimize this process, texture map addressing will roll over, repeating the same texture map repetitively on the polygon. This allows textures to cover large areas, such as terrain, with a reduced number of polygons. Control bits in the polygon allow texture smoothing to wrap around to the opposite side of a texture map to provide texture maps that repeat without any boundaries between the maps.

DATABASE FEATURES

MOVING MODELS, ARTICULATED PARTS, AND SPECIAL EFFECTS

Any model may be a moving model, articulated part of a moving model, or one of many models in an animated sequence for a special effect. Internal storage is provided for up to 4096 direction cosine matrices, which allows up to 4096 coordinates sets to be processed. From this total number, one matrix must be reserved for each active viewport.

DATABASE PAGING

With the release of version 4.0 of the PRO–API, users can implement dynamic database paging for real-time applications using the PRO–1000. Blocking structures are available to both swap in and out database sections and qualify a group of objects as potentially visible in the view pyramid. Although it is possible to keep over 400,000 polygons in memory simultaneously with 32 MB of polygon memory installed, dynamic database paging enables simulation or mission rehearsal scenarios to utilize virtually unlimited database sizes. Database paging is only supported for preformatted models. PRO-API version 4.0 provides the ability to save user defined run-time models as preformatted data.

DATABASE MANAGEMENT

As part of the overall database handling capabilities of the PRO–1000, LOD switching and performance monitoring are available to maintain maximum scene detail at real-time performance. This provides the flexibility to tune the polygon content of the visible scene to the optimum performance characteristics of the PRO–1000.

FEATURE PROCESSING

The PRO-1000 incorporates up to 128 different database feature types. These types can have different settings for size LOD and range LOD switching and discard processing. When the system encounters an overload condition, features can be blended out to reduce the load and attempt to maintain frame update rate. Trees, buildings, brush, and hills are examples of feature types that can be controlled.

IMMEDIATE MODE PROCESSING

REAL-TIME MORPHING AND POLYGON CONTROL

Limited direct control of the polygons being processed is possible in the REAL 3D PRO-1000 system. Polygons can be processed and sent into the rendering subsystem in real-time by way of the host software control. These polygons are then processed with those in local database memory to produce special effects. An example of this capability is 3D sea states, where a mesh of polygons is manipulated in real-time to create a moving ocean surface.

HIDDEN SURFACE REMOVAL

Hidden surface removal in the PRO–1000 is handled by a 24-bit floating point Z-Buffer. This provides a general purpose capability that can address any 3D data structure and resolve the visible content to the individual pixel level in real-time.

LEVELS OF OCCULTING

Inherent in a Z-buffer system, co-planar polygons can cause significant occulting problems. The REAL 3D PRO-1000 handles occulting problems with the use of a stencil buffer. The stencil buffer determines the highest priority polygon from a co-planar set and properly occults the lower priority polygons with the "stencil" of the higher priority polygon. This ensures that lines on the road, or tail numbers on an aircraft, do not disappear when they are in the same plane as the polygon from the underlying terrain or aircraft model.

ILLUMINATION

Light points are polygons that always face the viewpoint and are not affected by lighting, so they seem luminous during night scenes.

LIGHTS POINTS / CHANNEL

In the PRO–1000, polygons are traded one for one with light points. A single PRO-1000 can produce 33,000 lights or 33,000 polygons or any combination of the two totaling 33,000. If multiple primitives are used to model complex light structures, the quantity of lights processed will be less than 33,000. The actual light capacity of the system will then vary depending on the application.

LIGHTS POINTS / SYSTEM

Light points are limited only by the number of channels in a total system configuration.

LIGHT POINT FLEXIBILITY(S)

The placement, or arrangement of lights, is totally unrestricted in the PRO-1000 system.

LIGHT FEATURES AVAILABLE

The PRO-1000 light points are controlled by the host computer and can be made to flash, strobe, fade with distance, vary in intensity, and vary with view angles (e.g., VASI and FLOLS). All lights have a level of intensity to control fade and size relative to distance from the eyepoint. Directional, flashing, strobe, steerable, and scalable multi-colored lights are controlled by the host computer.

HEADLIGHT ILLUMINATION OR SPOTLIGHTS

The PRO–1000 can simulate headlights, spotlights, or landing lights. The hardware will support one headlight per viewport. The number of viewports is limited only by PRO-1000 system configuration and the database complexity. Viewports may overlap. The illumination pattern is an ellipse that can be scaled in the x and y directions. The maximum radius of the ellipse is 2047 pixels allowing the light lobe to cover adjacent displays. The direction of the light lobe and the size can be changed dynamically by way of the PRO-API. The extent of the illumination (the distance from the illumination source to the point where the illumination declines) can be specified. The intensity of the illumination decreases as a function of the inverse distance from the eyepoint to each pixel when the extent of the light lobe has been reached. Also, the illumination decreases as the square of the radius, as in the real world.

Headlight Illumination is designed to work with illumination sources that are close to the eyepoint such as illumination sources on the ownship. The color of the light may be red, green, blue, yellow, purple, cyan, or white.

SWITCH CONTROLS

All PRO-1000 lights can be independently controlled. Lights can also be grouped within the host so one command controls several lights.

GLARE EFFECTS OFF HAZE

This is a supported function of headlights / spotlights in the PRO–1000. Illumination is varied in the scene to provide the effect of glare as typically seen in fog.

VIEWPORTS

DEFINITION OF VIEWPORT

A viewport is a rectangular area of the screen. As many viewports as desired can be processed, subject to the processing resources of the system. Processing statistics are returned for four viewports as selected by the user. The viewports are processed sequentially. As a practical limit, four viewports can be opened in each display channel, and they can overlap. The priority of each viewport may be defined. Viewport priority ranges from 0 to 3. If the viewport priority of multiple viewports are the same and the viewports overlap, the polygons will merge and become one scene in the overlapping areas.

REAR VIEW MIRRORS

A rear-view mirror can be thought of as a viewport within a channel. All of the parameters used in a complete channel with special effects can be applied here. Since viewports have a full 3D transformation matrix applied to the database, a rear-view mirror in correct perspective and field of view (FOV) may be implemented. The host may independently flip the viewport in the horizontal and vertical directions using a PRO-API function call.

WEATHER EFFECTS

FOG

Local fogging is supported in the PRO–1000. The density and color of the fog can be dynamically changed. The amount of fog is a function of the amount of fog density (input from the host) and the distance from the eyepoint to the pixel.

VISIBILITY

Sufficient visibility accuracy is maintained to display features 40 miles from the viewpoint with a five degree minimum FOV.

SUPPORTED FEATURES OF WEATHER EFFECTS
- Haze
- Scud/layered clouds
- Programmable linear fade attenuation
- Sun position
- Dynamic ambient light
- Day/dusk/night color tables

3D SEA STATES

Three dimensional sea states are accomplished by using polygon data. The visual effect, in conjunction with color, is that sea states can be depicted by applying a sinusoidal motion model along with a real-time calculation of color. The effects of white caps are depicted by the application of 2D textures. The visual effect is water, which appears to be realistic, and has the properties of 3D wave motion along with white caps and wakes produced by objects in the water. The 3D sea state is directional, producing the effects of wind and current on the wave surfaces. Wave motion calculations are a function of the host computer. The PRO-1000 only provides the rendering of the resultant sea state calculations.

ANTI-ALIASING

The REAL 3D PRO-1000 uses a unique high-speed hardware anti-aliasing technique. The display is calculated at the same resolution as the pixel resolution. Polygon edge crossings are used to process and filter the image to generate a high-quality anti-aliased image. The result of edges of different surfaces cutting through the pixel will be weighed and the pixel colored accordingly. This eliminates many of the irritating raster graphics effects, such as stepping along edges of surfaces, and the caterpillaring effects seen when objects move across the screen. It also means that lights on nocturnal displays move smoothly and maintain correct relative positions with respect to other moving or static lights. The principal advantages of this high-speed hardware anti-aliasing method are that it can be readily applied with different display configurations and it is not restricted to a specific resolution.

LOAD MANAGEMENT

The processing time for up to four viewports can be read by the host computer to determine if an overload has occurred or is impending. Load management is accomplished by the host computer using these processing times to control LOD of models and terrain. Model level of detail is controlled as a function of the subtended angle of the model, or as a function of the model's distance from the viewer. A set of LOD control parameters can be assigned to each model, and the model LOD can be individually controlled by pixel size or distance. Translucency blending is provided for model LOD transitions. There may be up to 128 sets of LOD control parameters, and the LOD parameters may be controlled by the host.

OVERLOAD CONTROL

The PRO-1000 supports three overload modes; frame lock mode, overload protect mode and extended overload mode. Frame lock mode will reset and start another update period if the processing time runs over the specified update period (16.7ms/60 Hz update or 33.3ms/30 Hz update). Any polygons that have been processed will be loaded into the frame buffer and the picture will be incomplete. Overload protect mode will allow another update period to finish processing. In this case, the system will automatically drop to one-half the update rate (e.g., from 60 Hz to 30 Hz). No hysteresis is in effect for this mode. Extended overload will drop the frame rate as far as necessary to process all the polygons. The host computer may read these signals for synchronization purposes.

ANIMATION SEQUENCES

Animation sequences are supported for morphing polygon data and texture animation. Special effects, e.g., fire, explosions, craters, and 3D sea states, can be performed on the system by host control.

MISSION FUNCTIONS

HEIGHT ABOVE TERRAIN

Height above terrain (HAT) is determined by way of the host computer.

COLLISION DETECTION

Collision detection is performed by the host computer.

LINE OF SIGHT RANGING

Line of sight ranging is performed by the host computer.

TRANSLUCENCY

Polygons can be transparent as a result of LOD blending, texture, inherent polygon translucency and edge on translucency. The system supports up to 32 levels of translucency.

LUMINOUS POLYGONS

A polygon may be flagged as a luminous polygon. When flagged, it will remain bright as scene illumination fades (i.e., stays bright at night). Luminous polygons are not affected by shading calculations, lighting positions, or headlight illumination.

COLORS AVAILABLE

Each model may reference a color table. Each color table can store up to 4096 colors. A polygon may reference two different colors in a color table and have its final color be controlled by the viewport in which it is visible. Each individual polygon may be independently given a 24-bit color instead of indexing into a color table. Color table support enables the application developer to implement rapid dynamic changes to the database during program run-time.
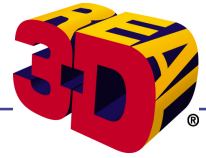
SHADING

The PRO-1000 Professional Series Image Generator supports fixed polygon shading, Gouraud polygon shading, and flat sun shading.

FIXED SHADING

Fixed shading, sometimes referred to as color interpolation, uses per-vertex color modulation scalar parameters, to shade the polygon in real-time. These per-vertex fixed shading parameters shade the polygon independent of the sun vector and sun intensity parameters. Fixed shading may be used alone or in combination with any texture mapping available on the system.

GOURAUD SHADING

Gouraud shading uses the vertex normals for all the vertices of a polygon. These normals are used along with the sun lighting parameters in order to calculate instantaneous shading intensities for each pixel based on the intensities at each vertex in real-time. Gouraud shading may be used alone or in combination with any texture mapping available on the system.

FLAT SUN SHADING

The flat sun shading model used in this system uses a single polygon normal and the sun lighting parameters (sun vector, ambient and sun illumination intensities) to calculate an instantaneous illumination value that is applied uniformly across the polygon in real-time. Flat sun shading may also be used along with any texture mapping available on the system.

MODELING TOOLS

In order to develop real-time simulation, mission rehearsal, and visualization applications, a user must generate databases for viewing and application programs to control the overall system. Database modeling for the PRO–1000 is easily accomplished using the Multigen Creator™ modeling application running on a variety of computer platforms. Multigen will produce an output file in Open–Flight (.flt) format, which is then loadable into the PRO–1000 for runtime use. The PRO–1000 can also load and utilize TARGET format databases designed for use with the CompuScene family of image generators.

Runtime application development may be based on the standard PRO–API software or may be based on higher level software packages such as OpenGVS from Gemini Technology. OpenGVS provides high level functionality such as collision detection, terrain following, and sophisticated vehicle dynamics, and sets an industry standard API for overall application development. Other third party software packages compatible with the PRO–1000 provide additional sophistication and convenience for the development of a wide variety of visual applications.

Datapath's RealiMation real-time tool set, a Windows NT graphical user interface for developing real-time applications, uses popular animation and modeling packages such as 3D Studio™, MultiGen, AutoCad®, Microstation® and emerging VRML formats. RealiMation provides menu-selectable renderers supporting Direct3D, OpenGL, REAL 3D's PRO–1000 series API and select custom renderers. This cross–platform capability will allow applications developed in one environment to be readily supported in another. A key feature of the RealiMation toolset is its support of Internet hot links from within the simulation environment.

Sense8's WorldToolKit®, recognized as the industry's most widely used visual simulation/virtual reality software toolkit, significantly expands the capability for PRO–1000 users to quickly and efficiently build custom real-time applications. It is a comprehensive package for developing and deploying visual simulation and 3D/VR applications. As an object–oriented C/C++ library, it contains more than 1,100 high-level function calls for configuring, interacting with and controlling real–time simulations. Function calls are used

to quickly and easily prototype, develop and reconfigure applications. For example, a single function call can do the work of 1,000 lines of C code, dramatically speeding the development of applications.

HOST INTERFACE

The PRO–1000 receives commands and data from a PC or workstation host computer by way of a differential fast-wide SCSI II bus. The host is able to control as many as seven separate PRO–1000 systems with only one SCSI II board. Multiple SCSI II interface boards can be installed and operating in one host. This allows many separate synchronized channels to be operating simultaneously.

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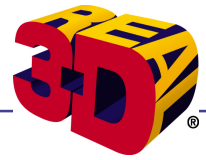tools, modeling, 30

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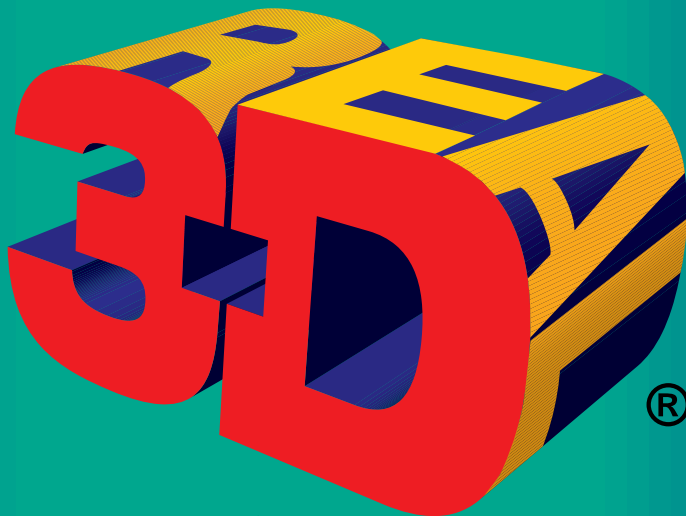
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