YASRT Raytracer

YASRT Version 0.1 Beta 14

User's Documentation

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Abstract:

This document is the user's manual for the YASRT Raytracer. It describes what YASRT is and what it's not. It walks the reader through a tutorial that shows the main features of the program. A full documentation on the YASRT language is also given. All tools that are part of the package are also described in this document.

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Introduction

This section presents the YASRT Raytracer. The main features are listed, along with current and future features. The section ends with installation notes for the different platforms supported.

What is it?

YASRT is a raytracing program. It uses the raytracing algorithm to generate realistic pictures from textual descriptions of three-dimensional scenes. It uses the metaphor of photography to achieve this goal. The photographer (*the user of the program*) uses a camera (*the program*) to shoot (*render*) photographs (*two-dimensional pictures*) of the surrounding world (*text description of a three-dimensional scene*).

By using advanced raytracing techniques, YASRT can simulate realistic optical phenomena such as: reflection (objects can be reflected in mirrors), refraction (object can be seen through other transparent objects), shadows are cast when the light is blocked by one or more objects, objects have different surface properties, etc.

YASRT is a program taking one or more files (text or binary files, depending on the platform) for input and generates a picture (binary file) of the scene described in these files. A description language allows artists to describe the scene to be rendered. Alternatively, it is possible to use different tools to export scenes from different 3D authoring tools. These tools are described later in this document. On some platforms, YASRT also supports the 3D Studio file format internally. Note that the support of the format is limited to the features present in YASRT (for example, image mapping is not yet supported in YASRT).

What is raytracing?

Raytracing is an algorithm that can be used to produce photo-realistic pictures of three-dimensional virtual worlds on a computer. It simulates the propagation of light through an environment by tracing rays of light in a scene to determine which objects they interact with. It also models physical properties of lights, objects and the interaction between them.

The simple approach of shooting rays from the lights present in a three-dimensional world is simple but primitive. Very few rays coming from these lights will eventually end up in the section covered by the camera. A simple method used in this case is to shoot rays from the camera out into the world. This technique is also known as backward raytracing.

Using the laws of geometric optics, rays can be reflected, refracted, focused, etc. The process is recursive in nature as rays are traced not only from the camera out into the world, but also out of a mirror, or inside a transparent object, etc. Using projection formulae, a pixel on the screen (or final output image) corresponds to one (or more) ray (depending on the different techniques used) that is sent out into the virtual world. Intersection tests are then conducted for each primitive to check if the ray hits one of these primitives. The algorithm then proceeds by determining the color on the surface of the primitive hit at the intersection point. Depending on the primitive's surface, new rays are traced (for example if reflection or refraction is activated), following the same algorithm. Finally, when a maximum number of iterations has been reached, or if the contribution of subsequent rays traced is not significant enough, the process is stopped. This process is then applied to all pixels of the image.

What is radiosity?

Radiosity is a complex algorithm used to simulate the global lighting of a scene. Since raytracing uses local optical laws (i.e.: laws that are applied at a single point, without taking into account its surrounding environment), it cannot take into account complex light transfer mechanisms that appear in the real world. An algorithm was developed to take into account these mechanisms. Radiosity is a view-independent algorithm that can be used in conjunction with raytracing to render realistic pictures. Without going into details, let's just say that this algorithm takes into account the effect such as:

- When no light directly reaches a part of a scene, it is rendered totally flat with the raytracing technique. By using radiosity, this part of the scene won't be flat, but resemble what's found in the real world.
- When bright surfaces (red for example) are placed near a white wall, this wall will have a faint red aspect (for example)

Though not supported in this current version, a global illumination algorithm will be added to YASRT in order to simulate the global illumination effects of a scene to render. The first implementation will probably be Path Tracing, the second one Photon Mapping.

Current Features

The following list describes what **has been** implemented in the current version of YASRT:

- Raytracing features:

1. Different camera models (flat and fisheye).
2. Advanced camera model with depth-of-field effect (when objects are not in the focus of the camera, they appear blurry like on photographs).
3. Lights with realistic distance attenuation (the intensity of the light diminishes with the distance from which an object is lit in the scene). Light attenuation models are: 1/d, $1/d^2$. This feature can be turned off if needed.
4. Point lights and spot lights supported.
5. All lights can cast soft shadows (penumbra) for more realistic pictures.
6. Support for different surface properties (Phong lighting model):
    - Intrinsic color
    - Ambient color
    - Diffuse color
    - Specular reflection
    - Transparency
    - Reflection (sharp and fuzzy).
    - Refraction
7. Simulation of haze
8. Different primitives supported:
    - Sphere
    - Cone
    - Plane
    - Polygon
    - Triangle
    - Smooth triangle (patch)
    - Ring
    - Cylinder
9. Distributed (or stochastic) raytracing: penumbra, fuzzy reflection, depth-of-field.
10. Acceleration technique (Kay & Kajiya) to speed up rendering times.

- Technical features:

1. Supported on several platforms:
    - Windows 9x, Me, 2000 and XP (Intel platform) and Windows NT (Intel and Alpha platforms)
    - Linux (Intel platform)
    - BeOS (Intel platform)
    - MacOS X (PowerPC platform)
    - Irix
    - Solaris (SPARC platform)
    - AIX
    - HPUX
    - PocketPC 3.0 and 2002 (ARM, SH3 and MIPS).

2. Multi-threading: YASRT can take advantage of multi-processor machines to speed up rendering times (support for 2, 4 and 8 threads currently).
3. Support for direct output onto the screen (platform-dependant).
4. Scripting language to describe the scene to render:
    - Environment settings: haze, background color, etc.
    - Camera settings: position, direction, field of view, depth of field, etc.
    - Lights descriptions
    - Primitives descriptions
    - Surface descriptions
    - Declaration of colors to re-use them throughout the scene
    - Inclusion of external files to re-use existing objects
    - Single-line and multiple-line comments
    - Output settings: anti-aliasing parameters, output file settings, etc.
5. Different image file formats supported:
    - BMP
    - PPM
    - TGA
    - JPEG (platform-dependant)
    - TIFF (platform-dependant)
    - PNG (platform-dependant)
6. Support for renderings of large amount of primitives.
7. Native support of the 3DS file format (platform-dependant).
8. Auxiliary tools to preview and convert the 3DS file format to the YASRT ASCII format (platform-dependant).

The following table summarizes the different technical features supported on the different platforms targeted by YASRT:

Platform	Supported Features	Comments
Win32 Intel	Multi-threading BMP, PPM, TGA, TIFF, JPEG & PNG Native 3DS file support 3DS file converter and pre-viewer	Primary target
Linux Intel	Multi-threading BMP, PPM, TGA, TIFF, JPEG & PNG Native 3DS file support 3DS file converter and pre-viewer	Secondary target
FreeBSD Intel	No Longer Supported	FreeBSD can execute Linux binaries
BeOS Intel	Multi-threading	OpenGL bugs for pre-

	BMP, PPM, TGA Native 3DS file support 3DS file converter	viewer: no longer supported
Win32 Alpha	Multi-threading BMP, PPM, TGA, TIFF, JPEG & PNG	Might not be supported in the future
Irix	Multi-threading BMP, PPM, TGA	None
AIX	BMP, PPM, TGA	Might not be supported in the future
DEC UNIX	BMP, PPM, TGA	Might not be supported in the future
HP-UX	BMP, PPM, TGA	Might not be supported in the future
Solaris	BMP, PPM, TGA	None
MacOS X	Multi-threading BMP, PPM, TGA	None
PocketPC	BMP, PPM, TGA	Limited support

Future Features

The following list describes what **will be** implemented in future versions of YASRT:

- Raytracing features:
  1. Stochastic global illumination to take into account global illumination effects (path tracing).
  2. Use of photon tracing for advanced effects: global illumination (not to be combined with path tracing) and caustics.
  3. More camera models: orthographic and no parallax.
  4. Area lights.
  5. Support for procedural texturing.
  6. Support for image mapping.
  7. Layered fog.
  8. New primitives:
     - Blobs
     - Height fields
- Technical features:
  1. Support for direct output onto the screen for more platforms.
  2. Support of any number of threads.
  3. Enhanced scripting language.
  4. Custom binary formats for easier and faster parsing and generation of large scenes.

5. More auxiliary tools in the package (converters, plug-ins for commercial 3D packages, etc.).
6. GUI for easier manipulation and rendering.

Installation Notes

Windows

To install YASRT on Windows, please do the following:

1. Download YASRT from its official Web Site: http://www.yasrt.org.
2. Download the Windows version for your platform (Intel or Alpha).
3. Unzip the archive downloaded (by using WinZip for instance) into a directory of your choice (e.g.: C:\YASRT).
4. Add the YASRT directory to your path environment variable:
    - On the desktop, right-click on the *My Computer* icon.
    - Select *Properties*.
    - Select the *Advanced tab* (Windows 2000).
    - Select *Environment Variables…*
    - In the system variables section, double-click on PATH.
    - Add YASRT directory (e.g.: C:\YASRT).

PocketPC

To install YASRT on the pocketPC platform, please do the following:

1. Download YASRT from its official Web Site: http://www.yasrt.org.
2. Download the pocketPC version for your platform (ARM only currently).
3. Unzip the archive downloaded (by using WinZip for instance) into a directory of your choice (e.g.: /YASRT).
4. The program reads a scene file called *scene.yst* at the root directory.
5. Copy any scene to the root directory and rename it to *scene.yst*, then run the program. The scene will be rendered directly onto the screen and saved in the image file specified in the script. To start the rendering phase, just tap on the screen.

Linux

To install YASRT on Linux, please do the following:

1. Download YASRT from its official Web Site: http://www.yasrt.org.
2. Download the Linux version for your platform (Intel only currently).
3. Uncompress the archive downloaded into a directory of your choice (/usr/local/yasrt for example), by doing the following:
    a. Open a Shell window
    b. Create the installation directory, e.g.: *mkdir /usr/local/yasrt*
    c. Copy the archive downloaded: *cp yasrtXXXX.tgz /usr/local/yasrt*
    d. Change the local directory to that created, e.g.: *cd /usr/local/yasrt*
    e. Uncompress the archive, e.g.: *gunzip –d yasrtXXXX.tgz*

    f. Untar the archive, e.g.: *tar –xvf yasrtXXXX.tar*
4. Add the YASRT directory to your path environment variable:

DEC UNIX

See the Linux Installation Instructions for more details.

HP-UX

See the Linux Installation Instructions for more details.

AIX

See the Linux Installation Instructions for more details.

FreeBSD

See the Linux Installation Instructions for more details.

Solaris

See the Linux Installation Instructions for more details.

Irix

See the Linux Installation Instructions for more details.

BeOS

See the Linux Installation Instructions for more details.

MacOS X

See the Linux Installation Instructions for more details.

Tutorial

This section is a tutorial that walks the user through the main features of YASRT. This section is not meant to replace the full user's reference section (see below), but is just an introduction to the main features of the Raytracer.

YASRT language features
Environment
Camera
Lights
Textures
Primitives

[THIS SECTION: TO BE ADDED]

YASRT Command-Line Options

YASRT is a command-line program (except for the pocketPC version which features a simple user interface). This means that it must be started from a shell or executed from an external program. This section describes all the command-line switches available to the program.

Note that the command-line options supersede the different directives given in the scene description file given as input. This allows having a set of directives for the final version of the scene, while still quickly allowing experimenting new features with shorter rendering times (by overriding this set of directives).

Some command-line switches are available on some platforms only, while others are common to all platforms. To quickly obtain a list of the different options supported for a given platform, simply type *yasrt* in a shell window.

Input and Output File Options

This section describes the different command-line options that apply to input and output files.

Input File

The scene to render is specified using the *–i* or *--input* switch followed by the name of the input file. For example:

C:\YASRT\yasrt.exe –i myscene.yst (on Windows platforms)
Or
/yasrt –i myscene.yst (on UNIX platforms)

In this case, YASRT will try to parse the file called *myscene.yst*.

Note that this is the only required switch to render a particular scene. All other switches override parameters describe in the *settings* section of the YASRT scripting language (see below).

Output File

1. Output File Name

The output file name can be changed by using the *–o* or *--output* switch followed by the name of the output file **<u>without any file extension</u>**. YASRT will automatically append the correct file extension based on the output file type.

For example:

```
C:\YASRT\yasrt.exe –i myscene.yst –o mysenefirstrender (on Windows platforms)
Or
/yasrt –i myscene.yst  –o mysenefirstrender (on UNIX platforms)
```

In this case the scene will be rendered to the myscenefirstrender image file. The extension of this file depends on the output format specified in the *settings* section of the script (the default being BMP).

2. Output File Type

   The output file type can be changed by using the appropriate switch. Here is the list of possible types:

   - BMP: by using the *–bmp* or *--bmp* switch.
   - TGA: by using the *–tga* or *--tga* switch.
   - PPM: by using the *–ppm* or *--ppm* switch.
   - PNG: by using the *–png* or *--png* switch (not supported on all platforms).
   - JPEG: by using the *–jpg* or *--jpeg* switch (not supported on all platforms).
   - TIFF: by using the *–tif* or *--tiff* switch (not supported on all platforms).
   - Screen output: by using the *–screen* or *--screen* switch (not supported on all platforms).

   For example:

```
C:\YASRT\yasrt.exe –i myscene.yst –o mysenefirstrender –ppm (on Windows
platforms)
Or
/yasrt –i myscene.yst  –o mysenefirstrender –ppm (on UNIX platforms)
```

In this case the scene will be rendered to the myscenefirstrender.ppm image file.

Raytracing Options

This section describes the different command-line options that apply to raytracing. It is possible for example to change the jittering and anti-aliasing options through the use of command-line switches. Future versions will add other features such as the possibility to adjust the quality of the rendering.

The anti-aliasing switches are the following ones:
1. For no anti-aliasing, use the *–aan* or *--aanone*.
2. For quick anti-aliasing, use the *–aaq* or *--aaquick*.
3. For adaptive anti-aliasing, use the *–aaa* or *--aaadaptive* followed by an integer representing the threshold value used by this algorithm. Low values give best results at the cost of the time spent to render the scene.

Jittering can be activated by using the *–j* or *--jitter* switch. Jittering introduce random effects in the way rays are shot in the world. The effect is to reduce the amount of aliasing in the final image.

To specify the size of the final image from the command-line, several switches are available:
- *-r* or *–resolution*: this switch is followed by two positive integers representing the width and height of the image to render.
- *-w* or *–width*: this switch is followed by a positive integer representing the width of the image to render.
- *-h* or *–height*: this switch is followed by a positive integer representing the height of the image to render.

For example:

```
C:\YASRT\yasrt.exe –i myscene.yst –aaa 24 (on Windows platforms)
Or
/yasrt –i myscene.yst –aaa 24 (on Unix platforms)
```

In this case the scene will be rendered using adaptive anti-aliasing with 24 as the adaptive distance.

For more information on anti-aliasing and jittering, please refer to the Environment section of the User's Reference part of this document.

Advanced Options

This section describes the different advanced command-line options available. Some of these options should be used with care as they change the way YASRT works internally (the value of the priority queue size for instance).

Multi-Threading

Some versions of YASRT support multi-threading. Multi-threading is a technique by which a program can execute several tasks in parallel. On machines with only one processor, even though the program appears to be doing several things at the same time, only one task is being executed at a given time. On machines with more than one processor and depending on the underlying operating system, the program will actually run its different tasks across the different processors available. If the program is executing more tasks than the number of processors, the different tasks will be shared among these processors. This sharing mechanism is also known as time slicing (processor time is sliced and divided among the different tasks to execute).

The multi-threaded version of YASRT uses threads to render the different parts of an image in parallel. By default, the workload involved in rendering an image is equally divided between the threads of execution. It is possible to increase that number. YASRT can support two, four or eight threads of execution to speedup rendering times. The default number of threads is 2.

To change the default number of threads, simply use the *–t* or the --*thread* switch followed by 2, 4 or 8.

For example:

```
C:\YASRT\yasrtmt.exe –i myscene.yst –t 8 (on Windows platforms)
Or
/yasrtmt –i myscene.yst –t 8 (on Unix platforms)
```

In this case the scene will be rendered by eight parallel threads.

3DS File Support

On some platforms, YASRT supports the rendering of 3D Studio binary files without needing the conversion of this type of files beforehand. In this case, two additional switches are available: the *-3ds* or the *–3ds* switch followed by the name of the YASRT configuration file (see next section), and the *-c* or the *––camera* switch followed by an integer representing which camera to use to render the scene (3DS files can have several cameras defined).

For example:

```
C:\YASRT\yasrt.exe –3ds myscene.yst (on Windows platforms)
Or
/yasrt –3ds myscene.yst (on Unix platforms)
```

Priority Queue Size

YASRT uses a complex technique to avoid testing the intersection of every single ray against every single primitive. When the number of primitives in the scene is large (thousands of objects), the program might bail printing an error message (*YASRT is out of space... Please use the -pqs or --pqsize switch to increase the priority queue size*). In this case the priority queue size of the algorithm must be increased (the default value is 128) by using the *-pqs* or the *--pqsize* switch followed by the new value of the size of the priority queue.

For example:

```
C:\YASRT\yasrt.exe –i myscene.yst –pqs 170 (on Windows platforms)
Or
/yasrt –i myscene.yst –pqs 170 (on Unix platforms)
```

YASRT will use priority queues with a size of 170 elements maximum.

Note: it is highly recommended to leave the default value of this parameter. This command-line switch should be used only when YASRT bails with the error message corresponding to an insufficient priority queue size.

Language Syntax

This section thoroughly describes the YASRT language used to describe 3d scenes. This section is the core of the YASRT reference manual.

File types

This section describes the different types of files handled by YASRT.

Input files

YASRT reads textual files as input files for scene description files (ASCII files). These files can be created using any text editor provided that they are saved as ASCII files with no extra formatting. Example of text editors include:

- Notepad (Windows).
- WordPad (Windows, be sure to save the file as Text only).
- TexPad (Windows, http://www.textpad.com).
- vi (Unix platforms).
- Emacs (Unix and Windows platforms).
- Etc.

Future versions of YASRT will support binary files when image mapping is supported. These binary files will be:

- PPM files (all platforms).
- BMP files (all platforms).
- TGA files (all platforms).
- JPEG files (depending on the platforms).
- TIFF files (depending on the platforms).
- PNG files (depending on the platforms).

On some platforms, YASRT also supports the rendering of 3D Studio binary files without needing the conversion of this type of files beforehand. An ASCII file needs to be created in order to tell YASRT how to render the scene. The content of that file is described in the corresponding section below.

Output files

YASRT supports binary files to output the images created. The formats supported are:

- PPM files (all platforms) – 24-bit (16M colors) – uncompressed.
- BMP files (all platforms) – 24-bit (16M colors) – uncompressed.
- TGA files (all platforms) – 24-bit (16M colors) – uncompressed.
- JPEG files (platform-dependant) – 24-bit (16M colors) – compressed.
- TIFF files (platform-dependant) – 24-bit (16M colors) – compressed.
- PNG files (platform-dependant) – 24-bit (16M colors) – compressed.

File inclusions

It is possible to include files within YASRT scene description files by using the *include* directive. This feature allows artists to create libraries of objects or libraries of colors, for example. What follows is an example of inclusion inside a script:

```
include "mycolors.inc"
include "myobjects.inc"
….
```

The *mycolors.inc* and *myobjects.inc* files are valid ASCII files containing YASRT objects, color declarations and so forth.

Data types

Before describing all the primitives supported by YASRT, it is important to present the different types of data that are manipulated by the raytracer.

YASRT supports different types of entities. This section describes these entities and gives examples on how to use them. These will serve as the basis for primitive declarations.

Integers

Integers are used by YASRT to determine integer numbers. Integer values can be positive, negative or null, depending on the context in which they are used. What follows is an example of the use of an integer in a YASRT script:

```
settings
{
	display 800 600
…
```

This example shows how to define the output format of the image to render. The first integer represents the width of the image; the second integer represents the height of this image (see below for more details).

Floats

Floats are used by YASRT to determine floating-point numbers. Float values can be positive, negative or null, depending on the context in which they are used. What follows is an example of the use of a float in a YASRT script:

```
settings
{
        haze_factor 0.345
…
```

This example shows how to define the contribution of haze in a scene (see below for more details).

Colors

YASRT makes extensive uses of colors in many of its structures. A color is defined by three floating-point components representing (in order of appearance): the red component, the blue component and the green component. What follows is an example of the use of a color in a YASRT script:

```
settings
{
        background 0.078 0.361 0.753
…
```

In this example, the background color of the image will have a red component of 0.078, a green component of 0.361 and a blue component of 0.753. Note that for 'normal' colors, the components lie between 0.0 and 1.0. When all components are null (0.0), the color specified is black; when they are all equal to 1.0, the color specified is white; additionally, when the components are all equal, the color specified is a shade of grey. Color components can be greater than 1.0 in the case of lights. As a matter of fact, as we will see later, light can fade proportionally with distance (like in the real world), if the color specified in the color structure is not sufficient (in this case the color of the light represents the intensity of the light), the scene won't be lit properly. For more details about this effect, see below.

Another way to use colors is by declaring them, as shown in the following example:

```
declare "AigueMarine"       color   .498039 1 .831373
…
```

This example shows how to declare a color called "AigueMarine" for later use in the script (the color can also be part of an include file as described before). For more details on the *declare* directive, see below.

Vectors

YASRT makes extensive uses of vectors in many of its structures. A vector is defined by three floating-point components representing (in order of appearance): the 'x' component, the 'y' component and the 'z' component. What follows is an example of the use of a vector in a YASRT script:

```
plane
{
	normal <0 0 1>
	distance -0.5
}
…
```

This example shows how to declare a plane. The '*normal*' vector represents the normal of the plane (for more details on the plane structure, see below).

Strings

YASRT uses strings in different elements of its scripting languages, generally textual directives. Strings are enclosed between double quotes ("). What follows is an example of the use of a string in a YASRT script:

```
settings
{
	output_type "bmp"
…
```

This example shows how to specify the BMP file format for the output image. For more details on the *output_type* directive, see below.

Variable declarations

To easily re-use different elements of the YASRT language within the same scene or to share these elements between different scenes, it is possible to declare elements (colors, floats, integer values, primitives, textures, etc.).

NOTE: the current version of YASRT only supports declaration for colors. Future versions of YASRT will support declarations for other elements of the language (integers, doubles, strings, surfaces, primitives, etc.).

The *declare* keyword is used for that purpose. The syntax of this keyword is as follows:

```
declare string data_type_name data_type_definition
```

In the current version of YASRT, *data_type_name* can only be "color". *data_type_definition* is therefore a color definition. For example, to declare a color and associate the name AigueMarine to it, use the following:

```
declare "AigueMarine"       color   .498039 1 .831373
…
```

To use this color later in the script, the following syntax needs to be used:

```
#color_name
```

For example, to use the color previously defined:

```
surface
{
        color #AigueMarine
…
```

It is therefore possible to define your own colors in include files, and re-use them in numerous scenes. Future versions of YASRT will support library paths: this feature will allow the raytracer to look for include files in specific directories without having to specify the full path to those files in the scenes using them.

3DS File Support

YASRT supports the 3DS file format natively. This feature has not been implemented on all platforms yet. Not all features of the file format are support either.

In order to activate this feature, an ASCII file must be created along with the 3DS file to render. This file specifies the different options that YASRT must apply to the scene when rendering it. The syntax of this file is the following:

```
{
        input_name          string
        output_type         string
        output_name         string
        attenuation_type    string
        shadow_type         string
        radius              double
        light_samples       integer
        camera_index        integer
        aperture            double
        focal_point         vector        or      focal_length          float
        camera_samples      integer
        background          color
        display             integer integer
        jpeg_quality        integer
        jitter              string
        antialiasing        string
        aa_distance         integer
        haze_color           color
        haze_factor         float
}
```

Note that this file contains only one section enclosed in curly brackets. Everything else in the file will be either ignored, or cause a parsing error.

Here is a description for each parameter of this structure:

1. *input_name*: this keyword is followed by a string that specifies the name of the input 3DS file. The filename has to contain the ".3ds" extension.
2. *attenuation_type*: this keyword is common to all light sources present in the 3DS scene. It allows specifying which light attenuation model to use during rendering. Possible values are:
   - *none*: no light attenuation will be used.
   - *d*: the attenuation will be proportional to the inverse of the distance from the light.
   - *d2*: the attenuation will be proportional to the inverse of the square of the distance from the light.
3. *shadow_type*: this keyword is common to all light sources present in the 3DS scene. It allows specifying which type of shadow to use during rendering. Possible values are:
   - *sharp*: the shadows cast in the scene will be sharp.
   - *smooth*: the shadows cast in the scene will be smooth. This effect is also referred to as penumbra. The output results are more realistic at the cost of longer rendering times.
4. *radius*: this keyword specifies the smoothness of the smooth shadows of the scene. Larger values lead to smoother shadows. The next keyword must be then used in order to avoid aliasing effects.
5. *light_samples*: this keyword specifies the number of additional rays to trace when smooth shadows are activated. Larger values lead to smoother shadows and less aliasing effects at the cost of longer rendering times.
6. *camera_index*: the 3DS file format support multiple cameras in the scene. In order to use one given camera in the scene, this keyword can be used.
7. *aperture*: this keyword allows activating the depth of field effect. The effect can be amplified by using large values, at the cost of rendering effects.

8. *focal_length*: this keyword is followed by a float that specifies the distance at which the scene is in focus. This parameter is not mandatory, its default value is 10. It can be used in place of *focal_point*. Both cannot be specified.
9. *focal_point*: this keyword is followed by a vector that specifies the point at which the scene is in focus. This parameter is not mandatory. It can be used in place of *focal_length*. Both cannot be specified.
10. *camera_samples*: this keyword allows controlling the number of additional rays that are traced when depth of field is activated. Large values will lead to smoother results and less aliasing effects at the cost of longer rendering times.
11. *display*: see previous section.
12. *output_type*: see previous section.
13. *output_name*: see previous section.
14. *jpeg_quality*: see previous section.
15. *jitter*: see previous section.
16. *antialiasing*: see previous section.
17. *aa_distance*: see previous section.
18. *background*: see previous section.
19. *haze_color*: see previous section.
20. *haze_factor*: see previous section.

The following example shows the declaration on a complete *settings* structure:

```
{
        input_name          "test3ds.3ds"
        output_type         "tga"
        output_name         "test3ds"
        display             800 600
        aa_type             "adaptive"
        aa_distance         16
}
```

The rest of this section explains features of the language that can be used only with the YASRT scripting language, not the 3DS file format support.

Environment

The *settings* section of the YASRT scripting language defines different directives concerning the rendering of the current scene. The syntax is the following:

```
settings
{
        display             integer integer
        output_type          string
        output_name          string
        jitter               string
        jpeg_quality         integer
        antialiasing         string
        aa_distance          integer
        background           color
        haze_color            color
        haze_factor          float
}
```

Here is a description for each parameter of this structure:

1. *display*: defines the resolution of the final image to render. The keyword is followed by two integers, the width and the height of the image, both in pixels. The *display* parameter is not mandatory; the default values are 320 (width) by 240 (height).
2. *output_type*: defines the type of the output. The keyword is followed by a string specifying the format of the output image. The value of this parameter depends on the platform and the support of image file types. See the release notes for more information on the formats supported for a particular platform. Possible values are:
   - "bmp": to specify the BMP file format.
   - "tga": to specify the TGA file format.
   - "ppm": to specify the PPM file format.
   - "jpeg": to specify the JPEG file format (not all platforms).
   - "tiff": to specify the TIFF file format (not all platforms).
   - "png": to specify the PNG file format (not all platforms).
   - "screen": to render directly onto the screen – no image will be saved by specifying this option (not all platforms). Note that this option will slow down renderings (on Windows platforms, rendering time are at least 50% bigger, in future versions this will be fixed).

   This parameter is mandatory and there is no default output file format.
3. *jpeg_quality*: this keyword is followed by an integer. It is supported only by versions of YASRT with JPEG support. The integer specifies the level of compression of the output image, it lies between 0 and 100. Low values correspond to lower file size (high compression), high values correspond to higher file size (low compression). There is no default value for this parameter.
4. *output_name*: this keyword is followed by a string that specifies the name of the output image file. The filename specified doesn't need to contain any file extension. YASRT will automatically append the correct file extension to the name specified.

5. *jitter*: this keyword is followed by a string specifying if jittering should be used during the rendering of the output image. Its value can be either '*yes*' or '*no*'. This parameter is not mandatory, and by default jittering is not activated. Jittering allows YASRT to introduce pseudo-random values when tracing rays. This feature is useful because it helps reducing the appearance of aliasing effects (see below) to the human brain. However, jittering shouldn't be used when generating the successive frames of an animation. Since pseudo-random values are used when tracing rays, undesired visual effects are generated (noise) when objects moved during animation.
6. *antialiasing*: this keyword is followed a string specifying the type of anti-aliasing to use during rendering. The different values can be:
    - '*none*': no anti-aliasing is used. This leads to the fastest renderings, at the cost of a poor quality in the results obtained. This technique should be used in intermediate renderings only.
    - '*quick*': a quick anti-aliasing technique is used. This provides a good trade-off between rendering times and rendering qualities, and is slower than with no anti-aliasing. This technique should be used in intermediate renderings only.
    - '*adaptive*': an adaptive anti-aliasing technique is used. Put simple, this complex technique recursively sub-divides each pixel and traces new rays until a threshold is reached (see below). As a result far more rays are traced than in any of the previous techniques presented. Calculation times are therefore tremendously increased; this is why this technique should be used for final renderings.

    The default value for this parameter is '*none*' (no anti-aliasing by default).
7. *aa_distance*: this keyword is followed by an integer that specifies the threshold value used when adaptive anti-aliasing is activated. Low values give the best results as more rays are traced; this therefore leads to longer rendering times. High values give good results with faster rendering times, at the cost of a poor quality in the final image. This parameter is not mandatory and its default value is 64.
8. *background*: this keyword is followed by a color that specifies the background color of the image. If a ray that is traced into the virtual world doesn't hit any primitive present, the color returned is that specified by this parameter. This parameter is not mandatory, and its default value is black (0 0 0).
9. *haze_color*: YASRT can simulate haze effects. This parameter is followed by a color specifying of the haze when this effect is activated. This parameter is not mandatory, and its default value is black (0 0 0).
10. *haze_factor*: this parameter is followed by a float value that specifies the importance of the haze effect in the scene. High values lead to thick haze.

A value of 0 means that the haze effect is not activated. This parameter is not mandatory, and its default value is 0.

The following example shows the declaration on a complete *settings* structure:

```
settings
{
        display             1024 768
        output_type         "jpeg"
        output_name         "myScene"
        jitter              "no"
        jpeg_quality        90
        antialiasing        "adaptive"
        aa_distance         32
        background          <0 0 0>
        haze_color           <1 1 1>
        haze_factor         0.05
}
```

Camera

The *camera* section of the YASRT scripting language defines the different parameters of the camera of the scene. The syntax is the following:

```
camera
{
        position            vector
        look_at             vector
        up                  vector
        projection_type     string
        fov                 float
        ratio               float
        aperture            float
        focal_point         vector        or    focal_length        float
        camera_samples      integer       or    samples             integer
}
```

Here is a description for each parameter of this structure:

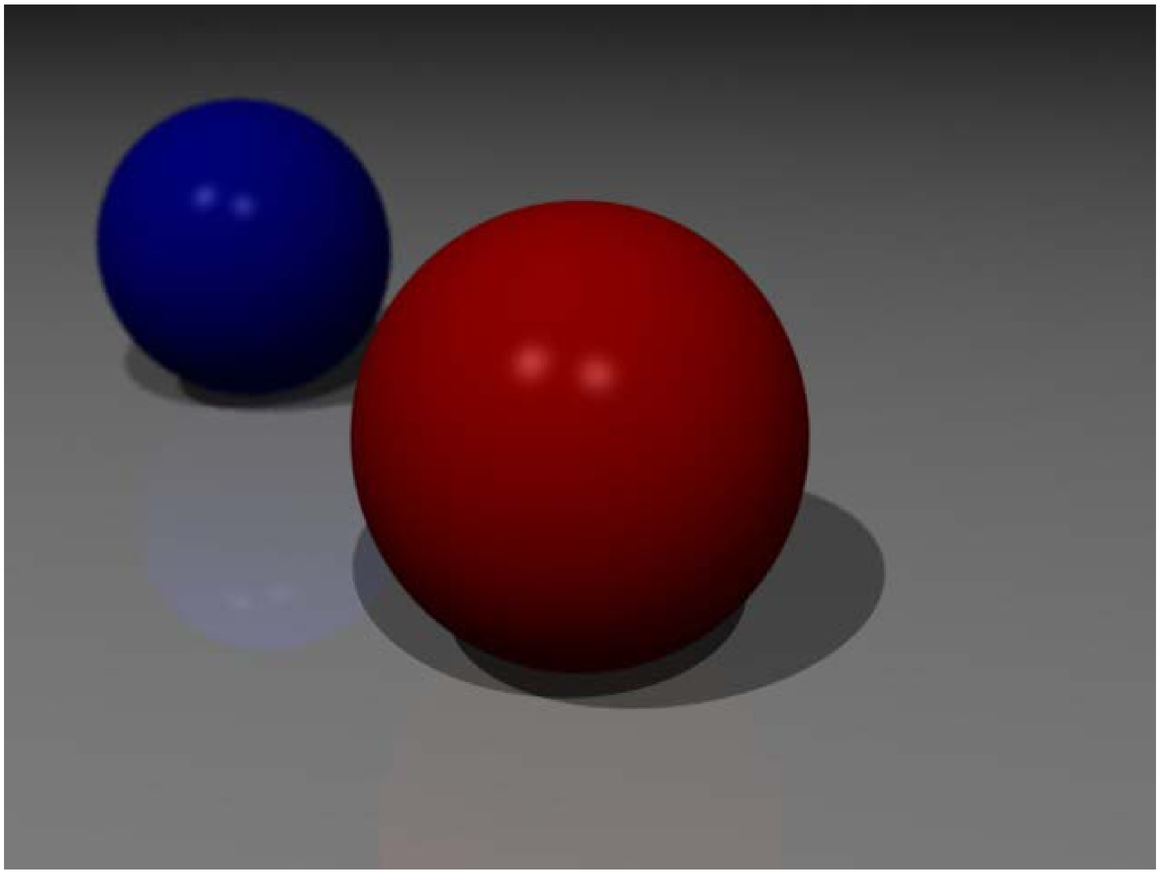
1. *position*: this keyword is followed by a vector that specifies the position of the viewer. This parameter is mandatory and there is no default value.
2. *look_at*: this keyword is followed by a vector that specifies where the viewer is looking at in the virtual world. This parameter is mandatory and there is no default value.

3. *up*: this keyword is followed by a vector that defines what vector should be considered as the altitude. For left-handed systems, the value is <0 1 0>, for right-handed systems, it is <0 0 1>. This parameter is not mandatory, its default value is <0 0 1> (YASRT is right-handed by default).
4. *projection_type*: this keyword is followed by a string that specifies the type of projection to use. Possible values are:
   - *flat*: standard 3d projection will be used.
   - *fisheye*: a fisheye projection will be used.
5. *fov*: this keyword is followed by a float that specifies the field of view in degrees. Small values will lead to an effect of zooming in (close up), while large values will lead to an effect of zooming out. This parameter is not mandatory; its default value is 45.
6. *ratio*: this keyword is followed by a float that specifies the ratio of the final image to render. Normal computer screens have a ratio of 4/3. Standard resolutions also use this ratio (640x480, 1024x768, etc.). This parameter is not mandatory, its default value is 4/3.
7. *aperture*: this keyword is followed by a float that specifies the importance of the effect of depth of field. This effect simulates that seen in real photographs where objects out of focus will appear blurry. Large values will lead to accentuating this effect. This parameter is not mandatory, its default value is 0.0 (no depth-of-field effect by default).
8. *focal_length*: this keyword is followed by a float that specifies the distance at which the scene is in focus. This parameter is not mandatory, its default value is 10. It can be used in place of *focal_point*. Both cannot be specified.
9. *focal_point*: this keyword is followed by a vector that specifies the point at which the scene is in focus. This parameter is not mandatory. It can be used in place of *focal_length*. Both cannot be specified.
10. *camera_samples*: this keyword is followed by an integer that specifies the number of extra rays to trace when depth of field is activated. Large values will slow rendering times but lead to better visual results. This parameter is not mandatory, its default value is 16.
11. *samples*: this keyword is the same as *camera_samples*.

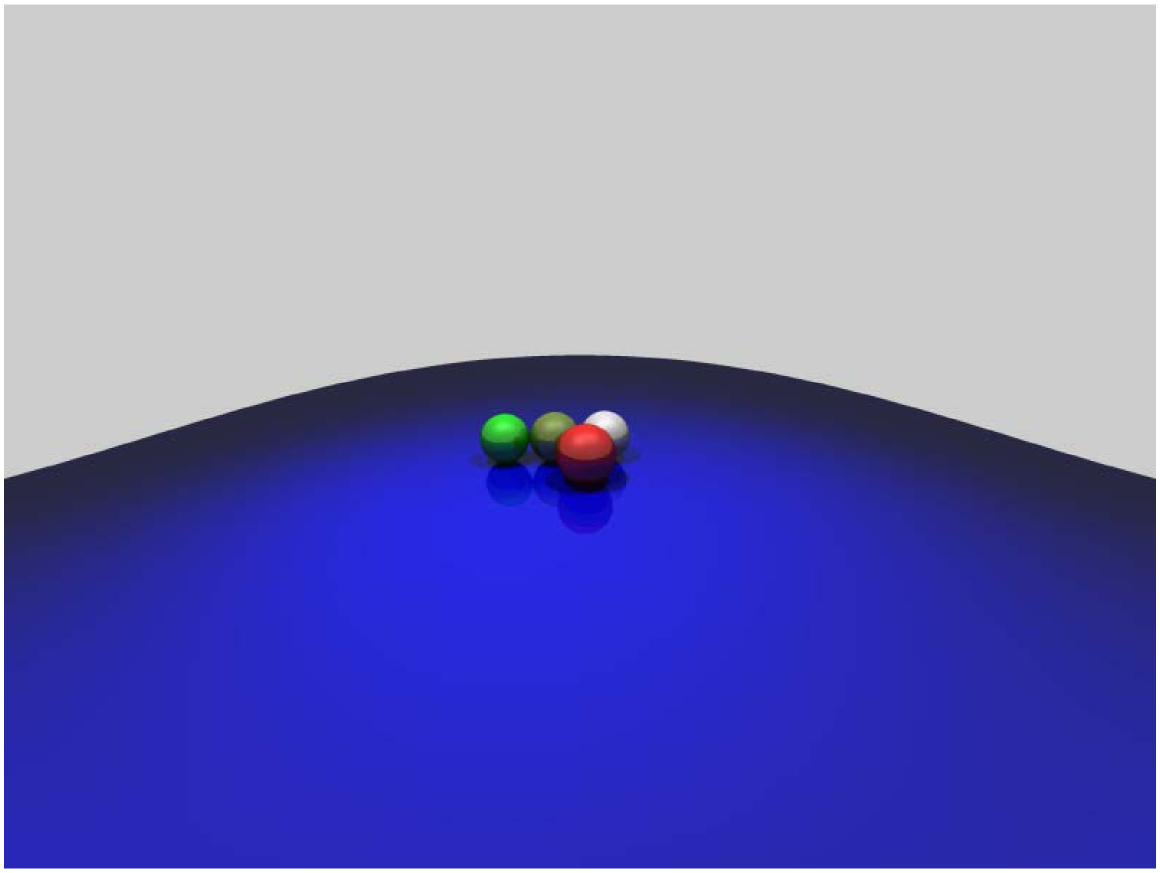
The following example shows the declaration of a camera:

```
camera
{
        position        <10 10 10>
        look_at         <0 0 0>
        up              <0 0 1>
        fov             60
        ratio           1.33333
        aperture        0.15
        focal_length    11
        samples         16
}
```

Here is an example of a scene using the depth of field effect:



The following example shows a scene using the fisheye projection:



Lights

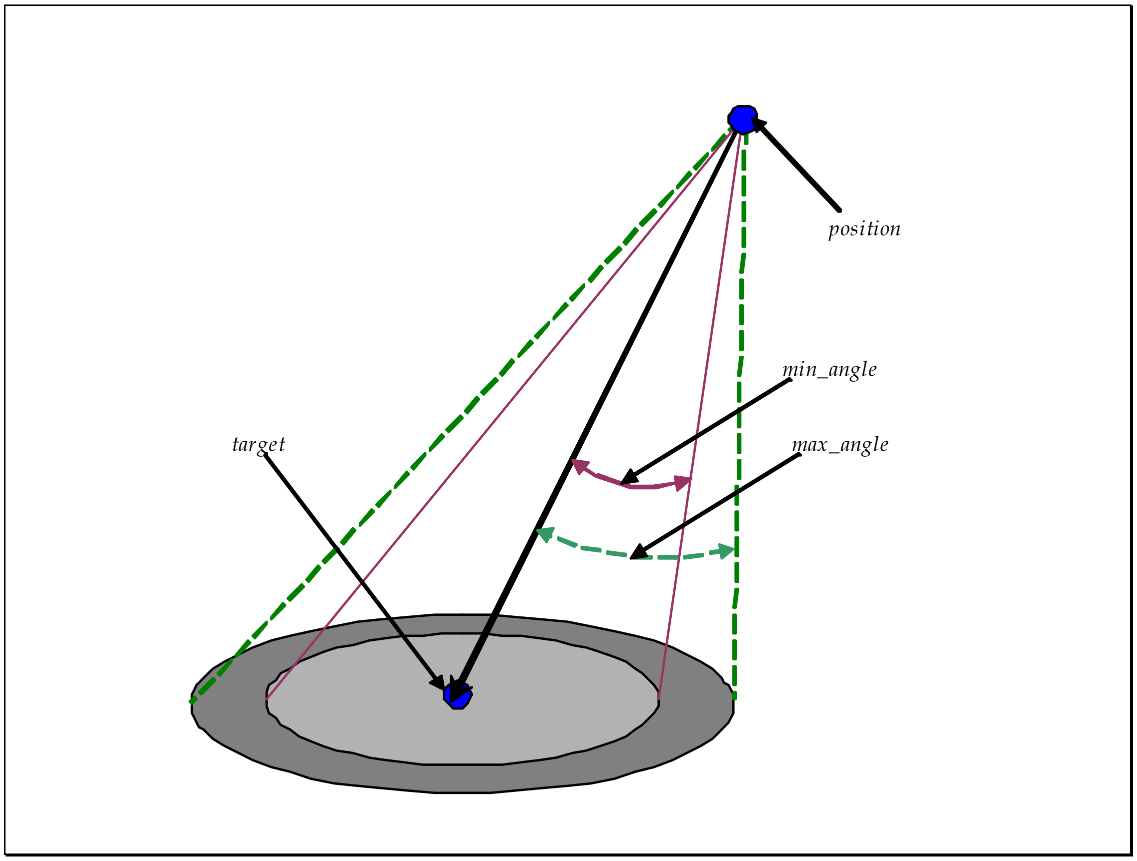
The *light* section of the YASRT scripting language defines the different parameters of the lights of the scene. The syntax is the following:

```
light
{
        position            vector
        target              vector
        color               color
        attenuation_type    string
        shadow_type         string
        radius              double
        min_angle           double
        max_angle           double
        light_samples       integer         or      samples             integer
}
```

Here is a description for each parameter of this structure:

1. *position*: this keyword is followed by a vector that specifies the position of the light. This parameter is mandatory and there is no default value.
2. *color*: this keyword is followed by a color that specifies the color of the light. Currently YASRT supports the effect of fading of intensity: the intensity of a light source decreases with the distance from the center of the light source. In this case, the color can be thought of as the intensity of the light. Since, this parameter depends on the overall scale of the scene, it needs to be carefully adjusted, and as a result, the color of a light can have its components greater than 1.0. This parameter is mandatory and there is no default value.
3. *attenuation_type*: this keyword allows specifying which light attenuation model to use during rendering. Possible values are:
   - *none*: no light attenuation will be used.
   - *d*: the attenuation will be proportional to the inverse of the distance from the light.
   - *d2*: the attenuation will be proportional to the inverse of the square of the distance from the light. This is the default value if the keyword is not present in the light declaration.
4. *shadow_type*: this keyword allows specifying which type of shadow to use during rendering. Possible values are:
   - *sharp*: the shadows cast in the scene will be sharp.
   - *smooth*: the shadows cast in the scene will be smooth. This effect is also referred to as penumbra. The output results are more realistic at the cost of longer rendering times.
5. *radius*: this keyword specifies the smoothness of the smooth shadows of the scene. Larger values lead to smoother shadows. The next keyword must be then used in order to avoid aliasing effects.
6. *light_samples* or *samples*: this keyword specifies the number of additional rays to trace when smooth shadows are activated. Larger values lead to smoother shadows and less aliasing effects at the cost of longer rendering times.
7. *target*: this keyword is used to specify the target point of a spot light.
8. *min_angle*: this keyword is used to specify the angle of the spot light under which the scene is fully lit. Its value must be lower than that of the *max_angle* parameter (see below).
9. *max_angle*: this keyword is used to specify the angle of the spot light under which the light diminishes. A point in the scene at an angle greater than this value will not be lit by the corresponding spot light.

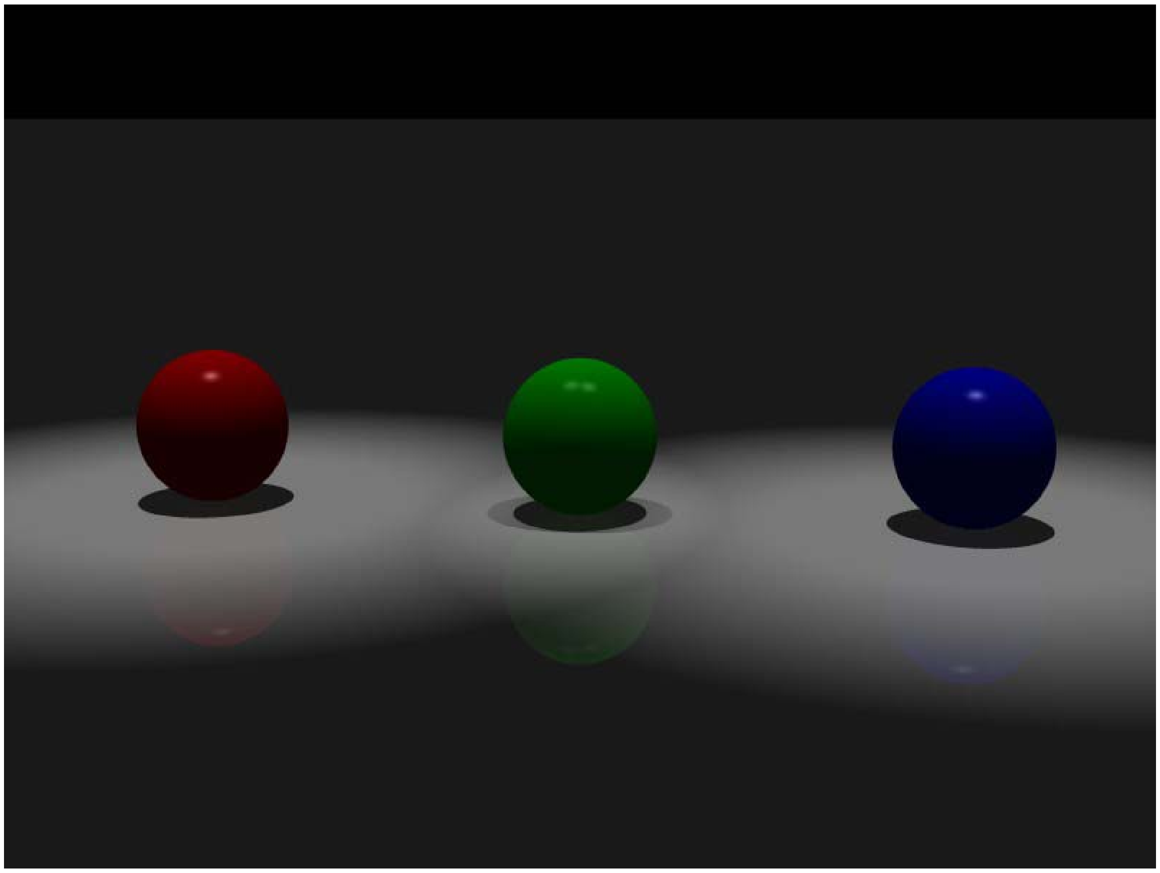
The following diagram illustrates the different parameters of a spot light:



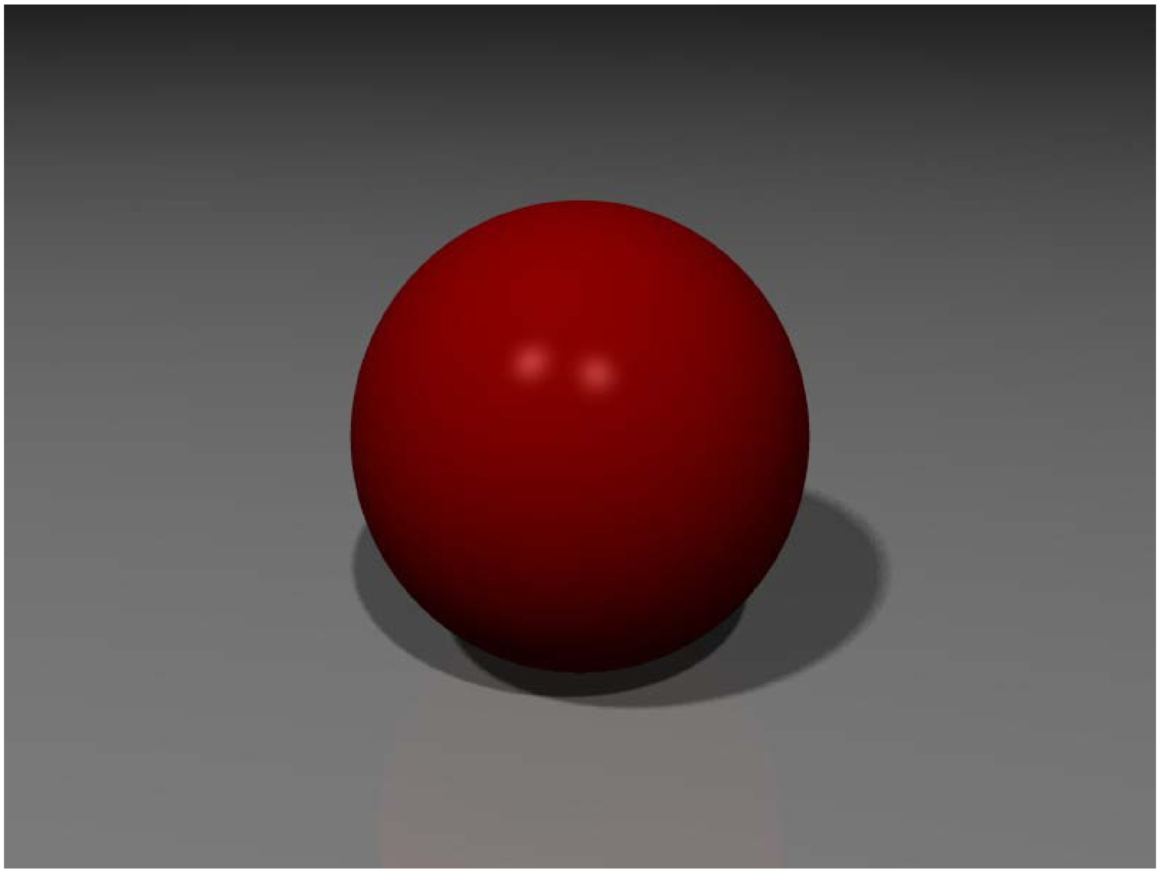
The following example is a light located at <10 10 10> and of a white color:

```
light
{
        position        <10 10 10>
        color           1 1 1
}
```

The following example shows a scene using two spot lights:



The following example shows a scene using soft shadows (penumbra):



Textures

The *surface* section of the YASRT scripting language defines the different parameters of the surface of an object. Currently, YASRT only supports some texturing features like: reflection, refraction and specular reflection. Future versions will support more advanced texturing models (procedural texturing, including: texture mapping, bump mapping, etc.).

Once a texture is declared in a script it is applied to all the objects that follow in the script. To change a texture, simply declare a new one, it will be used by all following objects within the script.

The syntax is the following:

```
surface
{
        color           color
        ambient         float
        diffuse         float
        brilliance      float
        specular            float
        roughness           float
        reflection          float
        reflection_type     string
        reflection_radius   float
        reflection_samples  integer
        refraction          float
        refraction_index    float
}
```

Here is a description for each parameter of this structure:

1. *color*: this keyword is followed by a color that specifies the intrinsic color of the object. This color will be used by the raytracing engine along with the following parameters in the structure to determine the exact color at a point on the surface of an object.
2. *ambient*: this keyword is followed by a float that specifies the ambient factor of the object. The ambient term in raytracing is used to simulate the effect of global illumination in a scene. Since standard raytracing cannot determine the exact value of this term, it is simulated by using a constant value. The value can range from 0.0 to 1.0. Typical values range from 0.1 to 0.3. Large value will render the object glowing.
3. *diffuse*: this keyword is followed by a float that specifies the amount of light that is reflected off the surface at the exact same angle it came in. This term is also known as *diffuse* reflection. A value of 0.5 means for example that 50% of the light seen from the object comes directly from the different light sources of the scene. The rest is absorbed by the object.
4. *brilliance*: this keyword is followed by a float that controls the way light interacts with the object depending on the incident angle. High values will make the object look more metallic.
5. *specular*: this keyword is followed by a float that controls the way highlights are generated when the light bounces off the object's surface. Simply put, highlights are the bright spots that appear on objects that depend upon viewing angle and illumination angle. The specular term can range from 0.0 to 1.0, 0.0 meaning no highlights, while 1.0 means total saturation of the highlight.
6. *roughness*: this keyword is followed by a float that controls the size of the highlight. Large values will give large highlights, while small values will give very smooth and small highlight.
7. *reflection*: this keyword is followed by a float that controls the amount of light that is reflected off the surface of the object. The value can range from 0.0 (no reflection) to 1.0 (total reflection). The light is reflected off the surface with the same angle as the incident light. Note

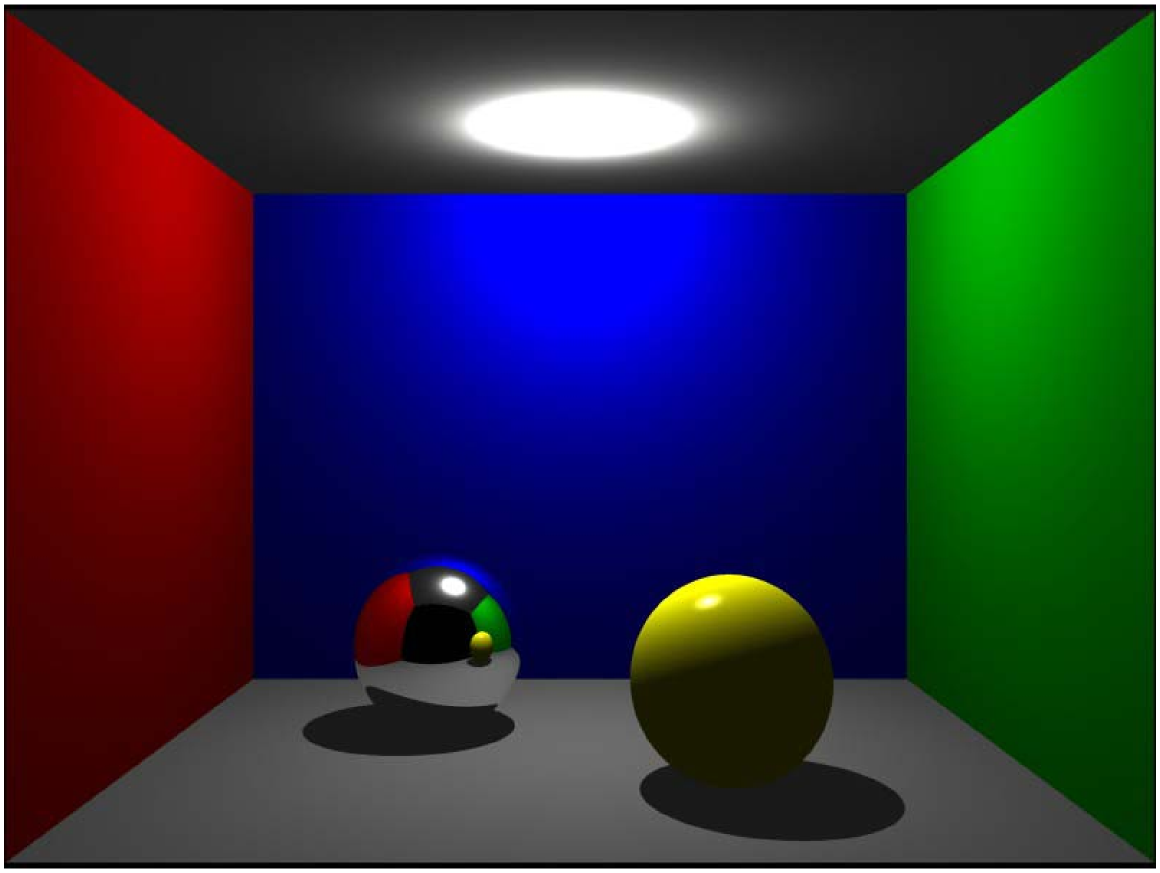
that reflection increases rendering times since new rays must be traced from the intersection point on the surface.

8. *reflection_type*: this parameter can be either *sharp* or *fuzzy*. *sharp* will use sharp reflections for the current surface (standard model), whereas *fuzzy* will activate fuzzy reflection. In this case the two following keywords must be specified.
9. *reflection_radius*: this parameter specifies how fuzzy the reflections can be. Large values will lead to more fuzzy reflections at the cost of more aliasing effects. In order to smooth the appearance of very fuzzy reflections, the following parameter must be adjusted.
10. *reflection_samples*: this parameter controls the number of ray samples that are reflected for each incoming ray. The larger the value, the better the results, at the cost of longer rendering times. Note that this parameter must be set according to the value of the previous parameter.
11. *refraction*: this keyword is followed by a float that controls the amount of light that is refracted by the surface. The value can range from 0.0 to 1.0. It can be thought of as the transparency of the object to which it is applied. Note that refraction increases rendering times since new rays must be traced from the intersection point on the surface. The default value is 0.0 (no refraction).
12. *refraction_index*: this keyword is followed by a float that specifies the index of refraction of the object. Typical values are: 1.0 for air, 1.33 for water, 1.5 for glass and 2.4 for diamond. The default value is 1.0 (air).

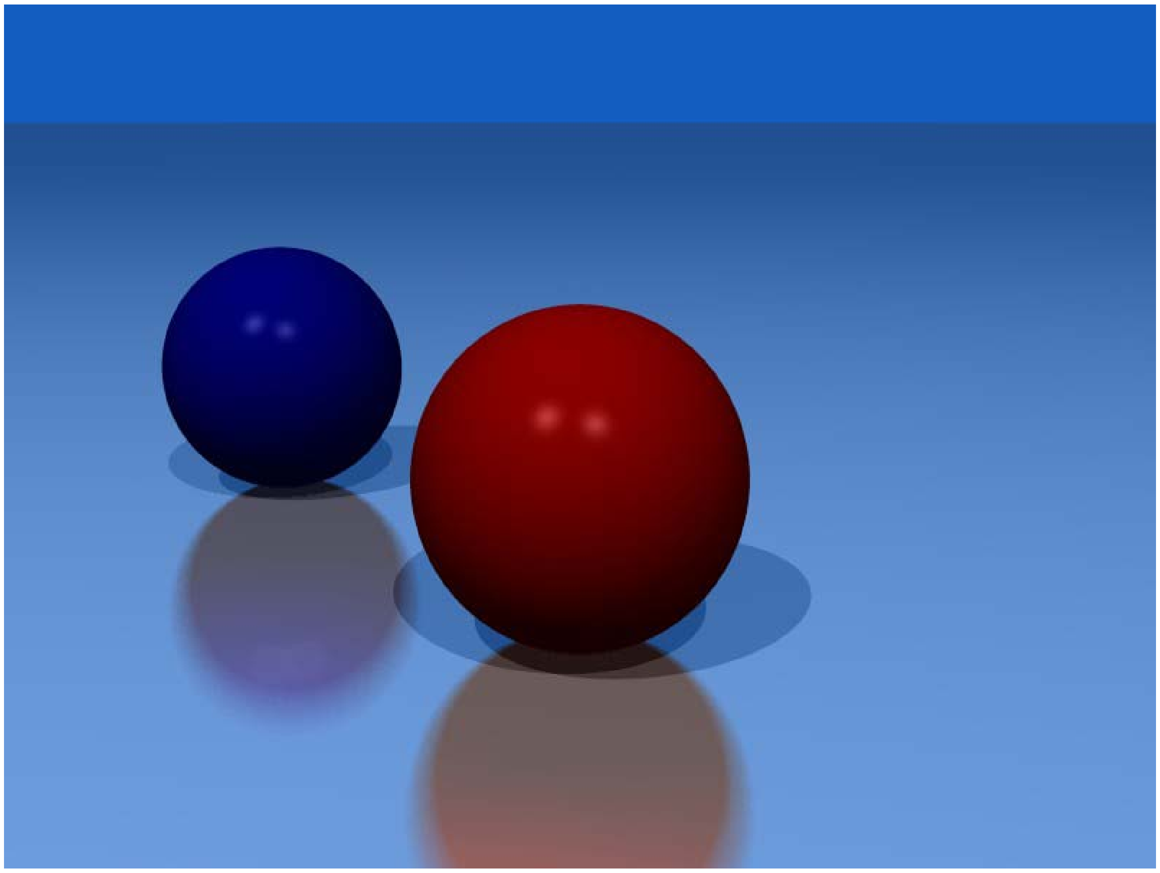
What follows is the example of simple surface declaration:

```
surface
{
        color               0.419 0.556 0.137
        ambient             0.1
        diffuse             0.75
        brilliance          1.0
        specular            0.3
        roughness           10.0
        reflection          0.25
        refraction          0.0
        refraction_index    1.0
 }
```

The following picture shows (the Cornell room) a scene where different types of surfaces are used:



The following picture shows the use of fuzzy reflections in a scene:



Primitives

This section describes the different primitives supported by YASRT.

Sphere

The sphere is the fastest and simplest object to render with a raytracing program. The syntax is a follows:

```
sphere
{
        center          vector
        radius          float
 }
```

Here is a description for each parameter of this structure:

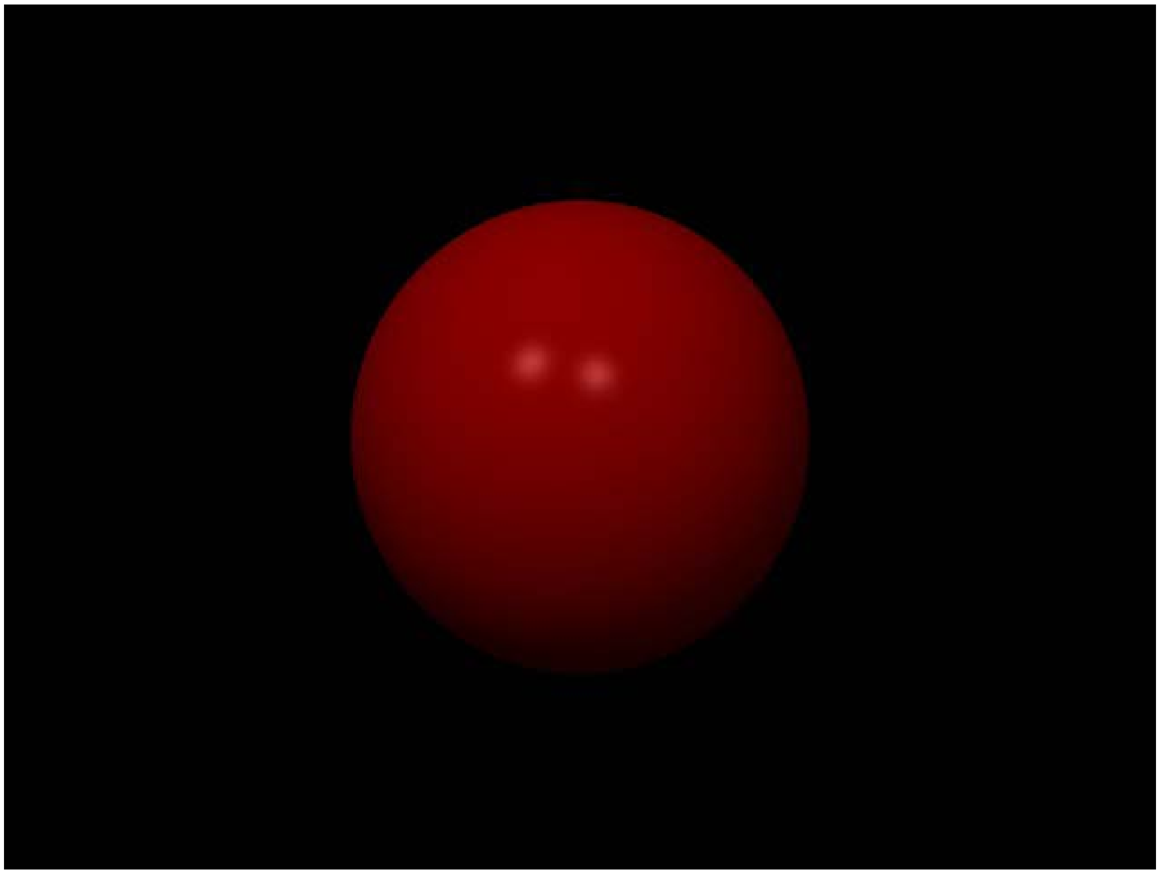
1. *center*: this keyword is followed by a vector that specifies the center of the sphere. This parameter is mandatory and there is no default value for it.

2. *radius*: this keyword is followed by a float that specifies the value of the radius of the sphere. This parameter is mandatory and there is no default value for it.

The following example shows of sphere centered around the origin (<0 0 0>) and with a unit radius (1):

```
sphere
{
        center          <0 0 0>
        radius          1
 }
```

The following image is an example of such a sphere:



Plane

The syntax is a follows:

```
plane
{
        normal          vector
        distance        float
}
```

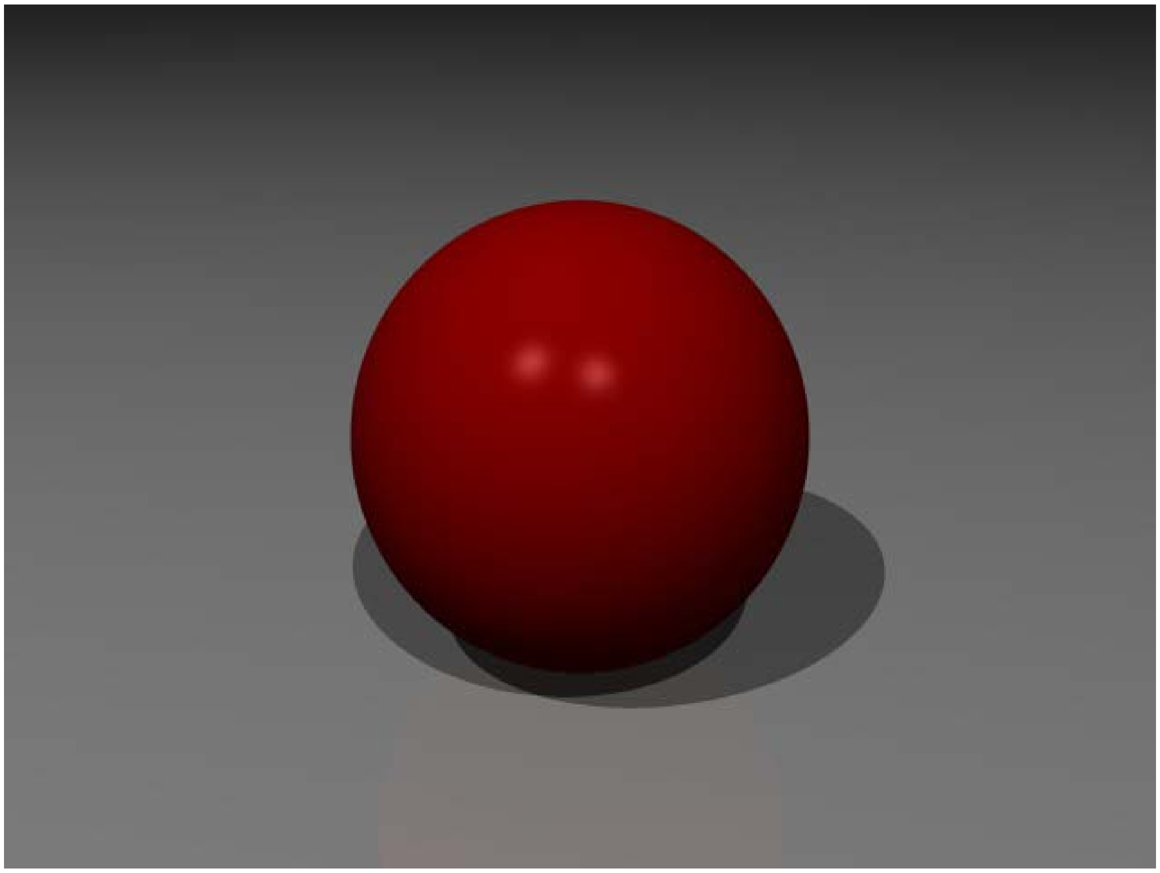
Here is a description for each parameter of this structure:

1. *normal*: this keyword is followed by a vector that specifies the normal of the plane. This parameter is mandatory and there is no default value for it.
2. *distance*: this keyword is followed by a float that specifies the value of the distance of the plane from the origin. This parameter is mandatory and there is no default value for it.

The following example shows the declaration of the (x, y) plane at one unit down on the z axis (i.e.: which equation is z=-1):

```
plane
{
        normal          <0 0 1>
        distance        -1
}
```

By adding this declaration to the previous scene, the plane is added to the scene:



Polygon

The syntax is a follows:

```
polygon
{
        integer
        vertex        vector
        vertex        vector
        vertex        vector
        vertex        vector
        vertex        vector
        …
}
```

Here is a description for each parameter of this structure:

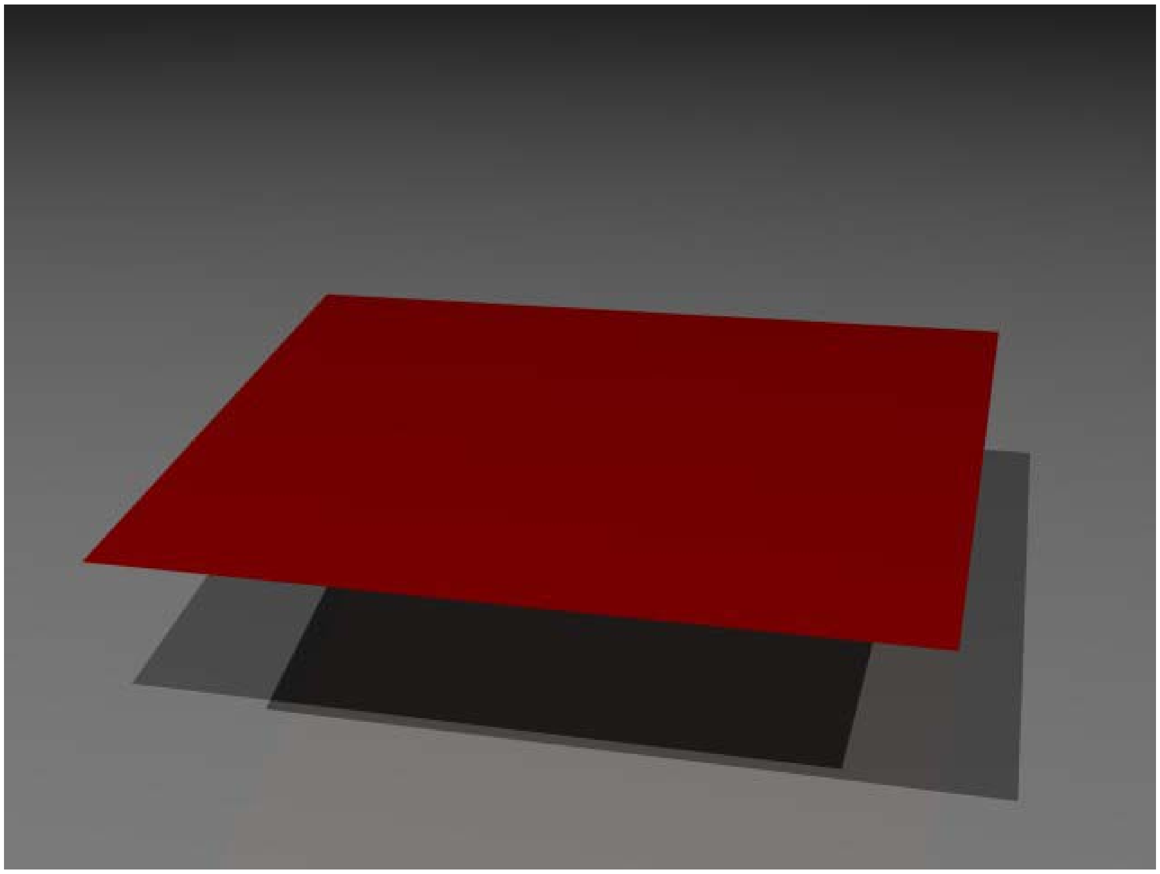
1. The first parameter of the *polygon* structure that specifies the number of vertices. This parameter is mandatory, it must be placed as the first entry of the structure and there is no default value for it. The number of vertices must be greater than three. For three vertices, use the triangle structure instead.

2. *vertex*: this keyword is followed by a vector that specifies one the vertices of the polygon. The vertices must be declared in the counter clockwise order.

The following example shows the declaration of a polygon:

```
polygon
{
        4
        vertex          <-1.5 -1.5 0>
        vertex          <1.5 -1.5 0>
        vertex          <2 2 0>
        vertex          <-2 2 0>
}
```

Here is such a polygon:



Triangle

The syntax is a follows:

```
triangle
{
        vertex          vector
        vertex          vector
        vertex          vector
}
```

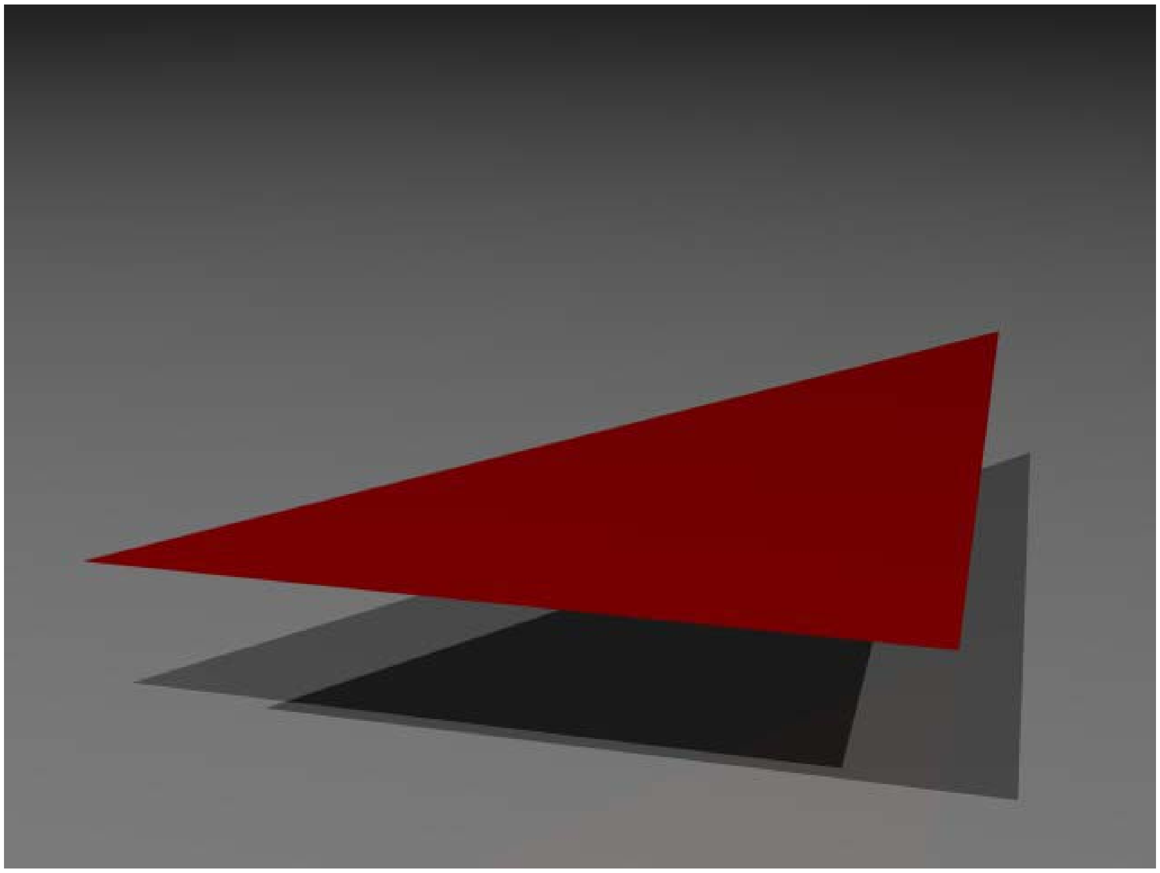
Here is a description for each parameter of this structure:

1. *vertex*: this keyword is followed by a vector that specifies one the vertices of the triangle. The vertices must be declared in the counter clockwise order. Only three vertices must be declared.

The following example shows the declaration of a triangle:

```
triangle
{
        vertex          <-1.5 -1.5 0>
        vertex          <1.5 -1.5 0>
        vertex          <2 2 0>
}
```

Here is such a triangle:



Smooth triangle (patch)

A smooth triangle contains not only vertices, but also the normal at each vertex. This primitive is primarily used when exporting scenes from commercial packages.

The syntax is a follows:

```
patch or smooth_triangle
{
        vertex          vector
        normal          vector
        vertex          vector
        normal          vector
        vertex          vector
        normal          vector
}
```

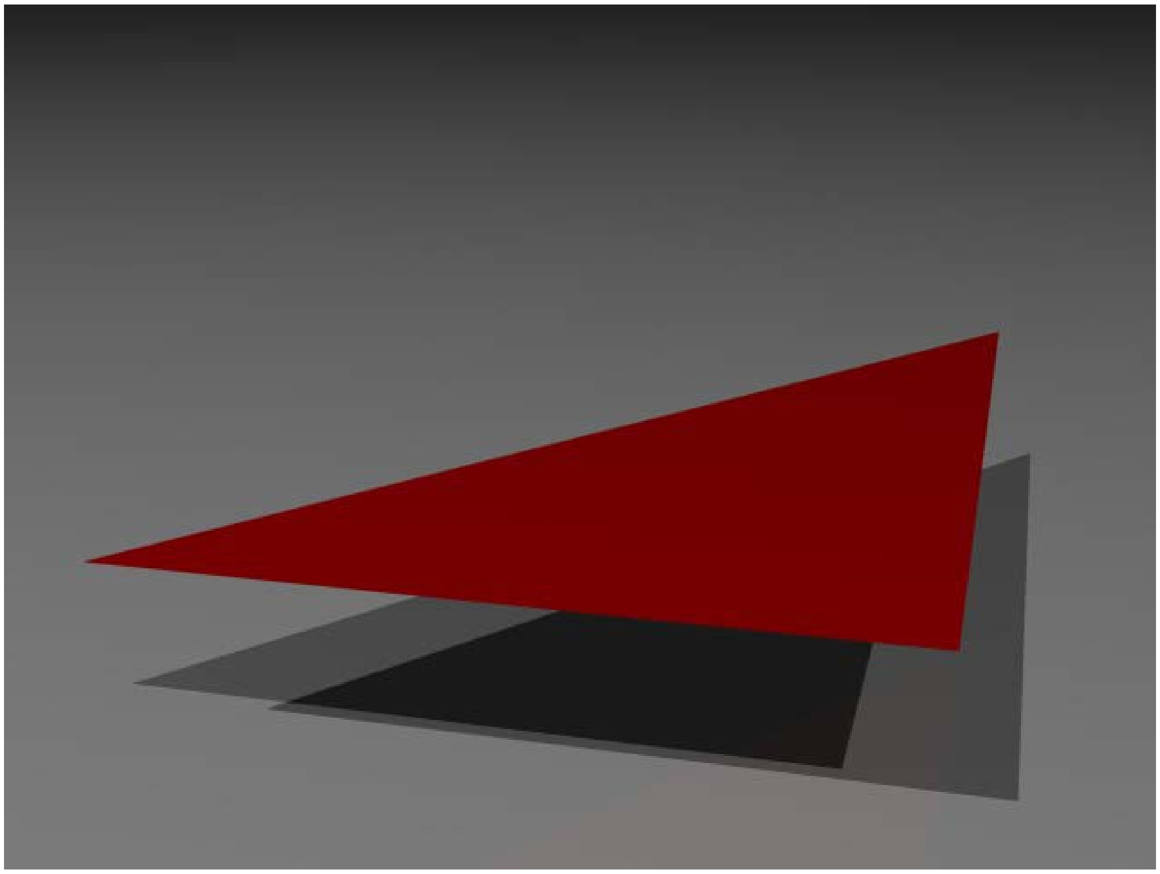
Here is a description for each parameter of this structure:

1. *vertex*: this keyword is followed by a vector that specifies one the vertices of the triangle. The vertices must be declared in the counter clockwise order. Only three vertices must be declared.
2. *normal*: each vertex must be **directly** followed by its normal.

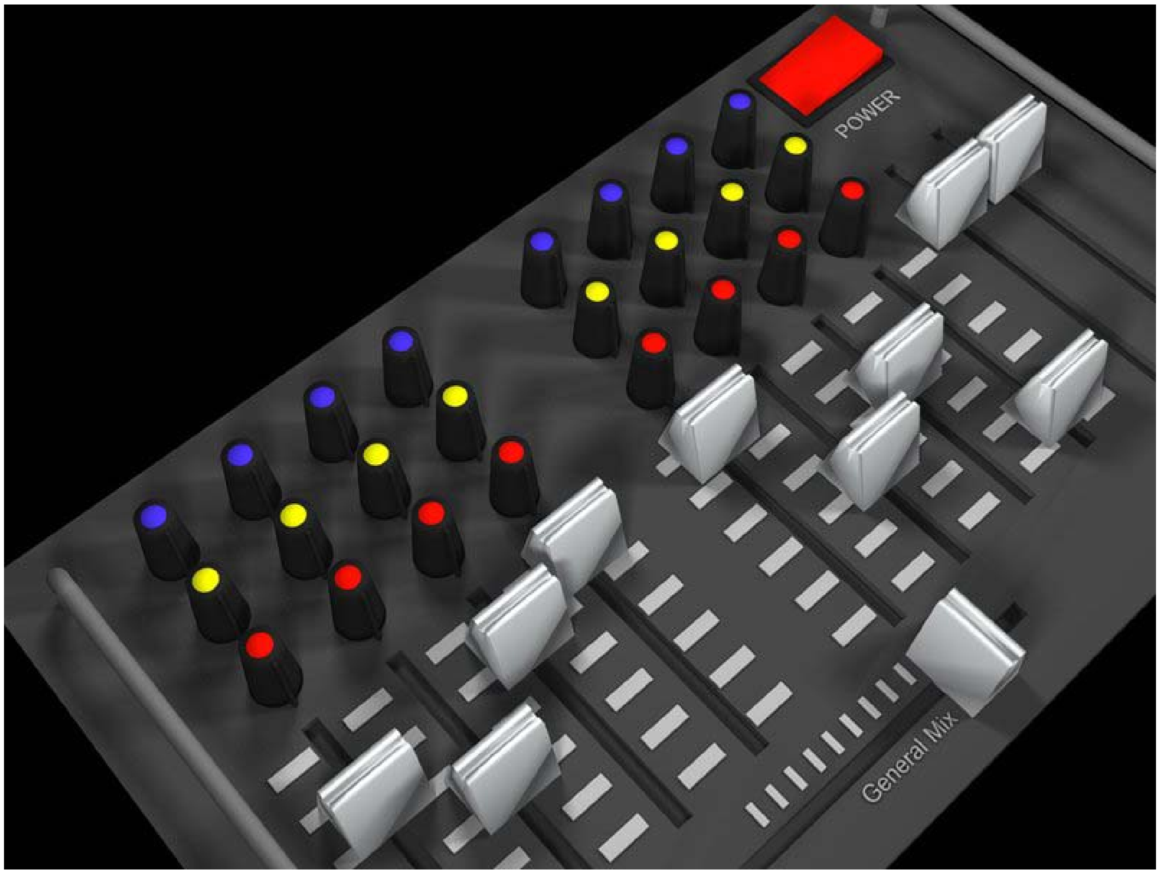
The following example shows the declaration of a smooth triangle:

```
smooth_triangle
{
        vertex          <-1.5 -1.5 0>
        normal          <0 0 1>
        vertex          <1.5 -1.5 0>
        normal          <0 0 1>
        vertex          <2 2 0>
        normal          <0 0 1>
}
```

Here is such a smooth triangle:



The following picture shows the use of a large amount of smooth triangles in a scene (3DS file courtesy of Ludovic Bridant):



Ring

The syntax is a follows:

```
ring
{
        center              vector
        normal              vector
        internal_radius     float
        external_radius     float
}
```

Here is a description for each parameter of this structure:

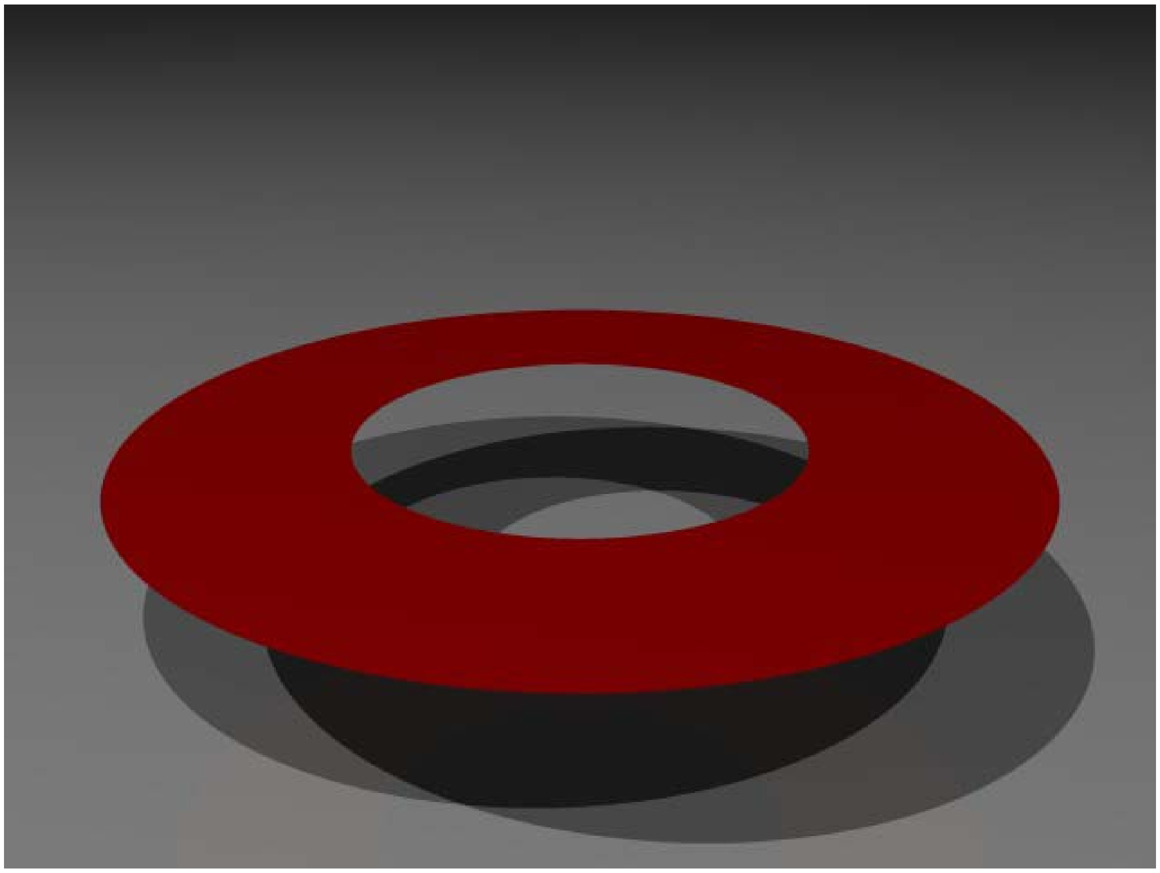
1. *center*: this keyword is followed by a vector that specifies the center of the ring. This parameter is mandatory and there is no default value for it.

2. *normal*: this keyword is followed by a vector that specifies the normal of the ring. This parameter is mandatory and there is no default value for it.
3. *internal_radius*: this keyword is followed by a float that specifies the value of the internal radius. This parameter is mandatory and there is no default value for it.
4. *external_radius*: this keyword is followed by a float that specifies the value of the external radius. This parameter is mandatory and there is no default value for it.

The following example shows the declaration of a ring:

```
ring
{
        center              <0 0 0>
        normal              <0 0 1>
        internal_radius      1
        external_radius     2
}
```

Here is this ring rendered:



Disc

The syntax is a follows:

```
disc
{
        center          vector
        normal          vector
        radius          float
}
```

Here is a description for each parameter of this structure:

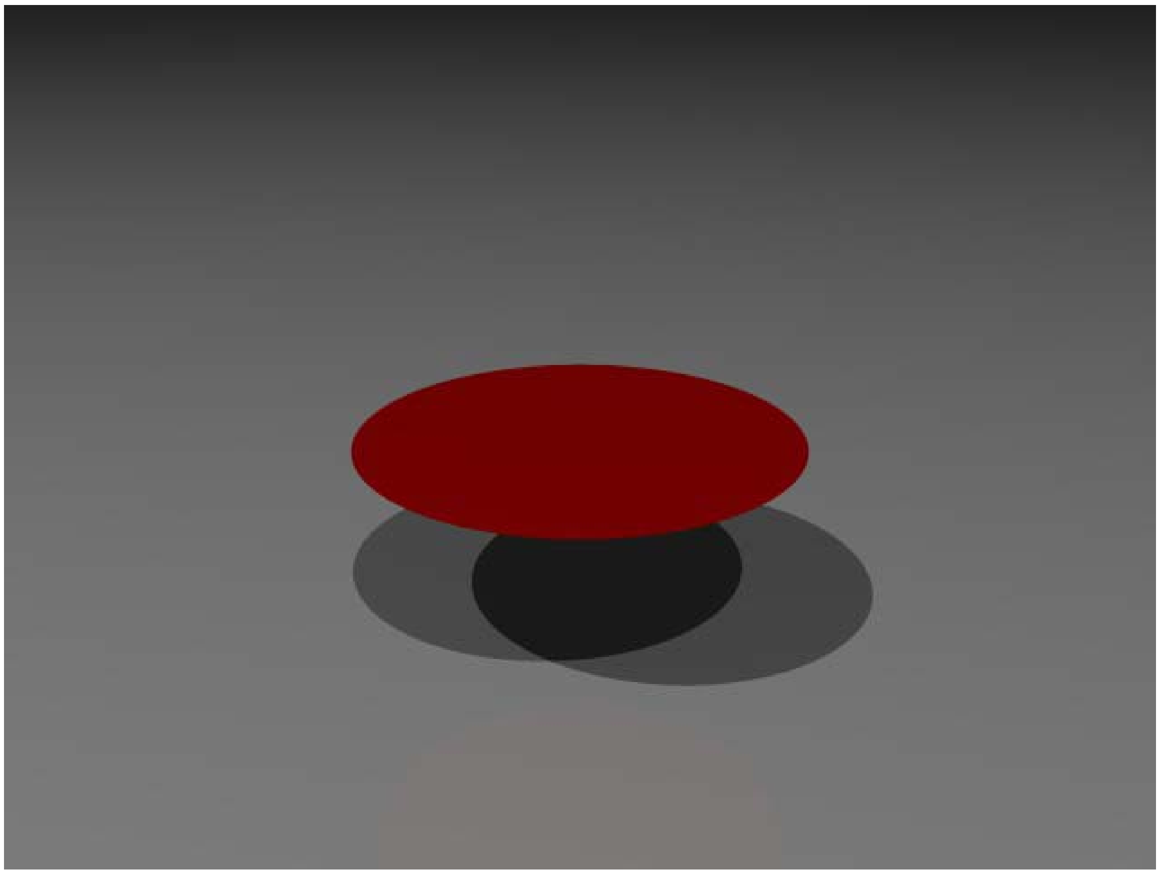
1. *center*: this keyword is followed by a vector that specifies the center of the ring. This parameter is mandatory and there is no default value for it.
2. *normal*: this keyword is followed by a vector that specifies the normal of the ring. This parameter is mandatory and there is no default value for it.

3. *radius*: this keyword is followed by a float that specifies the value of the radius. This parameter is mandatory and there is no default value for it.

The following example shows the declaration of a ring:

```
disc
{
        center          <0 0 0>
        normal          <0 0 1>
        radius          1
}
```

Here is this disc rendered:



Cone

The syntax is a follows:

```
cone
```

```
{
        base            vector
        cap             vector
        base_radius     float
        cap_radius      float
}
```

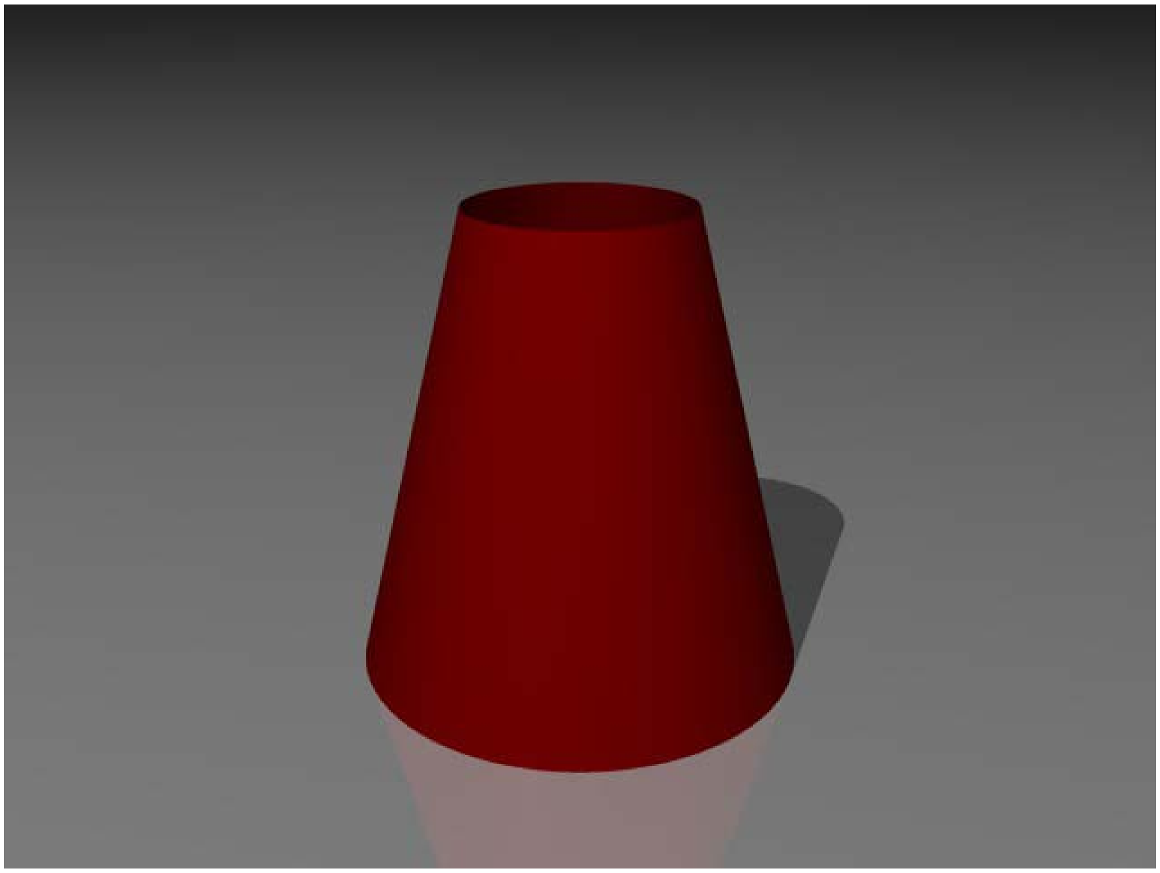
Here is a description for each parameter of this structure:

1. *base*: this keyword is followed by a vector that specifies the base of the cone. This parameter is mandatory and there is no default value for it.
2. *base_radius*: this keyword is followed by a float that specifies the value of the radius of the cone at the base. This parameter is mandatory and there is no default value for it.
3. *cap*: this keyword is followed by a vector that specifies the cap of the cone. This parameter is mandatory and there is no default value for it.
4. *cap_radius*: this keyword is followed by a float that specifies the value of the radius of the cone at the cap. This parameter is mandatory and there is no default value for it.

The following example shows an example of cone centered around the origin (<0 0 0>) and with a unit radius (1), that extends along the z axis on 5 units (<0 0 5>), and has a radius of 0.5 at the cap:

```
cone
{
        base            <0 0 -1>
        cap             <0 0 1>
        base_radius     1
        cap_radius      0.5
}
```

Here is this cone rendered:



Cylinder

The syntax is a follows:

```
cylinder
{
        base        vector
        cap         vector
        radius      float
}
```

Here is a description for each parameter of this structure:

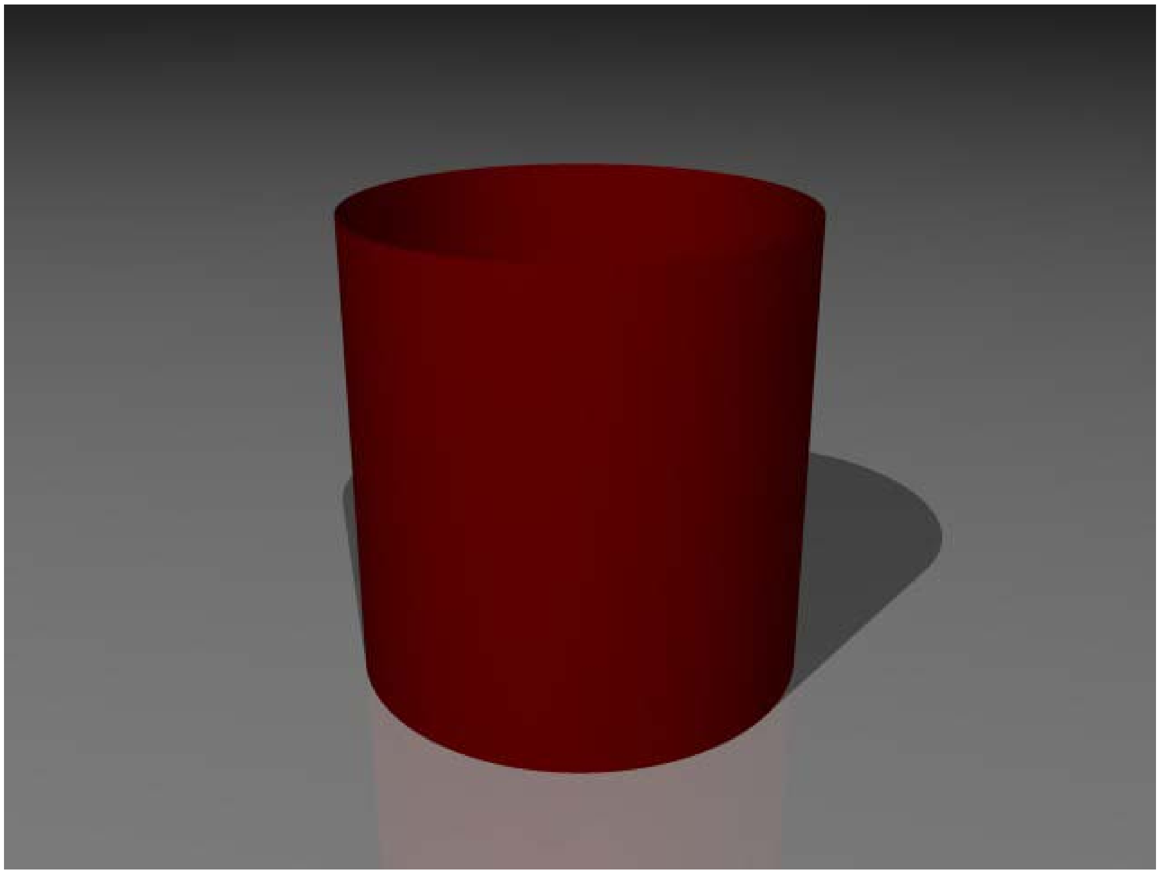
1. *base*: this keyword is followed by a vector that specifies the base of the cylinder. This parameter is mandatory and there is no default value for it.
2. *cap*: this keyword is followed by a vector that specifies the cap of the cylinder. This parameter is mandatory and there is no default value for it.

3. *radius*: this keyword is followed by a float that specifies the value of the radius of the cylinder. This parameter is mandatory and there is no default value for it.

The following example shows an example of cylinder centered around the origin (<0 0 0>) and with a unit radius (1), that extends along the z axis on 5 units (<0 0 5>):

```
cylinder
{
        base            <0 0 -1>
        cap             <0 0 1>
        radius          1
}
```

Here is this cylinder rendered:



Tools

This section describes the different tools bundled with YASRT. Depending on the platforms, these tools may or may not be present. Future versions will include more tools in the package.

The 3DS file conversion utility: 3ds2yst

The *3ds2yst* utility is a command-line program. It must be called from a shell (UNIX) or a command-prompt (windows). It is currently not supported on all platforms. However, it can be used to convert and then render a scene that was modeled in an external package. The 3DS file can then be converted to a YASRT ASCII file and rendered on a platform where the 3DS file format is not natively supported.

The following summarizes how to the program can be called:

Usage: 3ds2yst [*options*]		
Options:		
-i/--input	string	specify the file to open (**with** 3ds extension)
-o/--output	string	specify the output file (no extension)
-c/--camera	integer	specify the initial camera to use
-t/--triangle		triangles as output (default is patches)
-?/--help		this help message
Example: *3ds2yst -i car.3ds -o cartest*		

The 3DS file pre-viewer and converter: gl3ds2yst

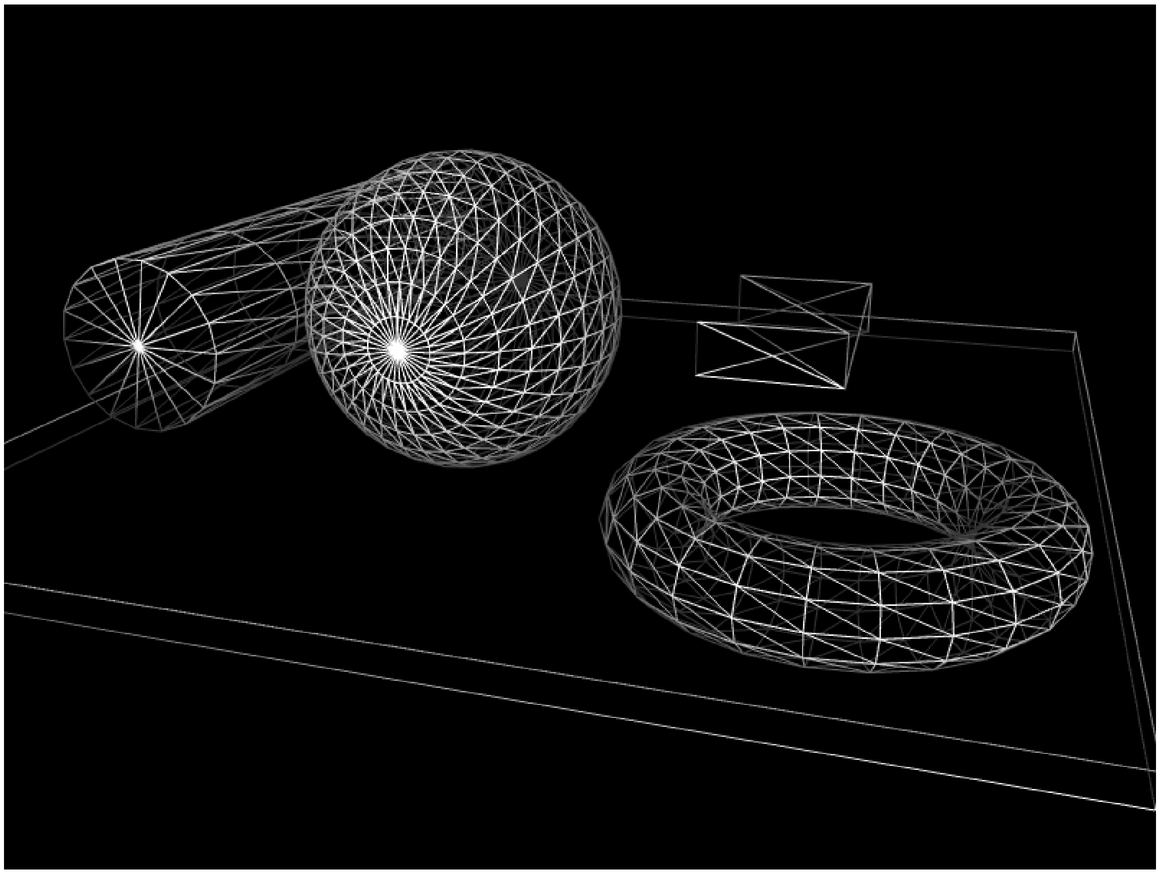
The gl*3ds2yst* utility is a command-line program. It must be called from a shell (UNIX) or a command-prompt (windows). It is currently not supported on all platforms. It is very similar to *3ds2yst*, but adds also the possibility to preview the 3DS scene before converting it. Additionally, it can be used to take screenshots from the OpenGL rendering window with anti-aliasing in different file formats.

The following summarizes how to the program can be called:

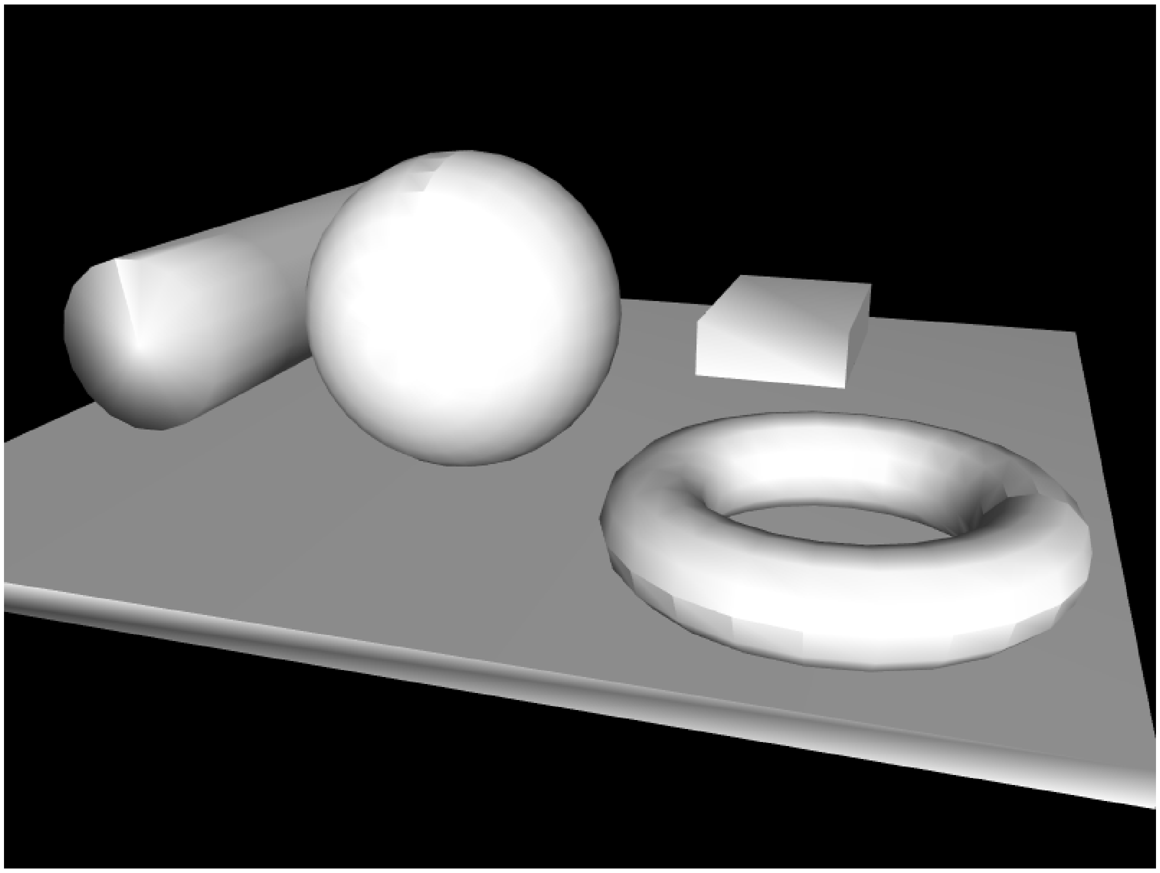
Usage: gl3ds2yst [*options*]		
Options:		
-w/--width	integer	width of the output image
-h/--height	integer	height of the output image
-d/--display	string	type of display (points, lines, triangles)

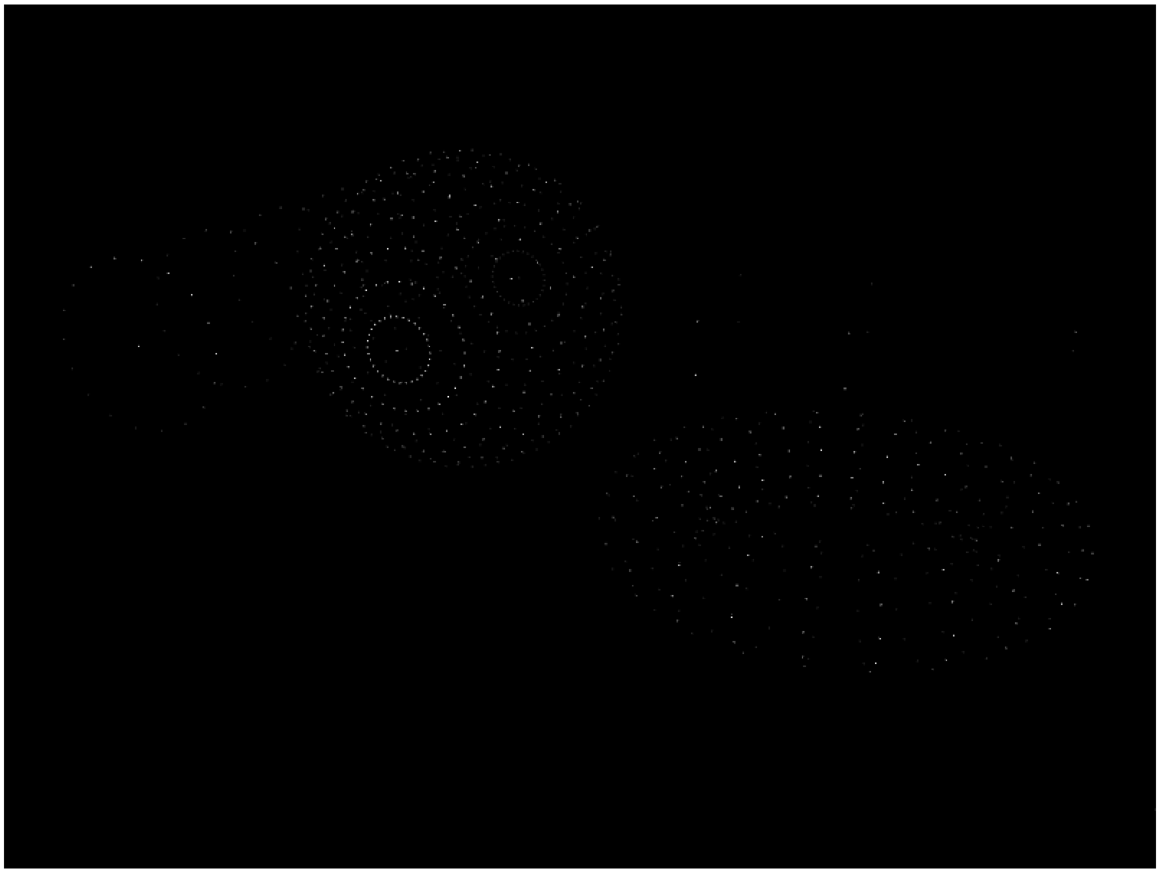
-o/--output	string	YASRT file to export to (no extension)
-c/--camera	integer	the initial camera to use
-i/--input	string	file to open (with extension)
-l/--light		load lights in OpenGL (experimental)
-t/--triangle		triangles as input (default is patches)
-x/--texture		load textures in OpenGL (experimental)
-?/--help		this help message
Example: gl*3ds2yst -i car.3ds -o cartest*		

By default, the 3D view will be displayed in wire-frame mode as shown below:



By using the appropriate command-line switch, it is possible to use a shaded or point rendering mode, as shown in the two following screenshots:





It is possible to interact with the keyboard and mouse. By left-clicking and moving the mouse (while keep the left button pressed), it is possible to look around in the 3D world of the scene. The right button of the mouse activates or de-activates the automatic animation of the scene (rotation around the target point of the camera).

The keyboard interactions are summarized below:

Key	Description
>	Go to the next camera in the 3DS file
<	Go to the previous camera in the 3DS file
-	Enlarge the camera field of view, thus giving the impression of zooming out
+	Reduce the camera field of view, thus giving the impression of zooming in
a	Activate/de-activate the animation of the scene (rotation around the target point of the camera)
A	Same as a
b	Make a screenshot of the screen to a BMP file (auto-incremented)

B	Same as b
c	Dump the objects and the settings of the scene in the specified *inc* and *yst* file.
C	Make a screenshot of the screen to a TGA file (auto-incremented)
d	Activate/de-activate the creation of the successive anti-aliased frames of an entire animation of the scene in PNG format
D	Same as d
f	Switch to full screen mode
F	Same as f
i	Make a screenshot of the screen to a PPM file (auto-incremented)
I	Same as i
j	Anti-alias the view on the screen
J	Same as j
k	Make a screenshot of the screen to a JPG file (auto-incremented) (platform-dependent)
K	Same as k
n	Switch to normal resolution
N	Same as n
o	Dump the objects of the scene in the specified *inc* file.
p	Make a screenshot of the screen to a PNG file (auto-incremented) (platform-dependent)
P	Same as p
q	Exit the program
Q	Same as q
s	Dump the settings of the scene in the specified *yst* file.
t	Make a screenshot of the screen to a TIFF file (auto-incremented) (platform-dependent)
T	Same as t
y	Cycle between wire-frame, plain and point rendering mode
Y	Switch between flat and shaded model

Future Tools

More tools will be added along the evolution of YASRT.