

# **RayStorm Documentation**

Andreas Heumann

<b>COLLABORATORS</b>
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	<i>TITLE :</i> RayStorm Documentation		
<i>ACTION</i>	<i>NAME</i>	<i>DATE</i>	<i>SIGNATURE</i>
WRITTEN BY	Andreas Heumann	November 11, 2024	

<b>REVISION HISTORY</b>
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NUMBER	DATE	DESCRIPTION	NAME

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# Chapter 1

## RayStorm Documentation

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## 1.2 RayStorm Documentation

25 April 1996

R a y S t o r m    v1.22

by Andreas Heumann and Mike Hesser

Introduction	What is RayStorm?
Requirements	What do I need to run it?
Features	What can RayStorm do?
Installation	How can I install it?
ARexx interface	Which commands doe it have?
Examples	How do I use the examples?
Tutorials	Some tutorials
Tips&Tricks	Useful tips,tricks and hints
Textures	How do I use textures?
Known bugs	Bugs
Legal Stuff	Legal stuff
Register	What must I do to register?
Credits	Thanks go to...
Authors	Who had written it?
PC-Version	Where can I get the PC-version?
Homepage	Where to find us on the World Wide Web
History	What happened in the past?
Future	What is planned for the future?

## 1.3 Introduction

### INTRODUCTION

RayStorm has been written to be as fast as possible, and use as less memory as possible. Thus we have implemented a octree algorithm, and optimized all calculations as much as we could.

Originally, RayStorm has been developed on Amiga using Maxon C++ 3.0 Developer.

The PC version has been compiled with WATCOM C++ 10.5.

This demo version is limited to a resolution of 160x128.

The full version is unlimited. Use the registration program to register.

#### FUNDAMENTALS ABOUT RAYTRACING

- General
- Octree
- Antialiasing
- Depth of field
- Soft shadows
- Surfaces
- Internals
- Virtual Memory
- Motion Blur

## 1.4 General

### GENERAL

Raytracing makes it possible to generate fotorealistic pictures of objects.

A raytracer casts a ray form the position of the viewer through a scene and calculates the intersections with the objects in that scene. If a intersection is found, the raytracer decides which color the object at this position has. If the object is reflective or transparent, the raytracer casts new rays from this positon and tests the intersections again and so on.

To make the surfaces of the objects more realistic, textures which simulate marble or clouds or water or other surfaces can be used.

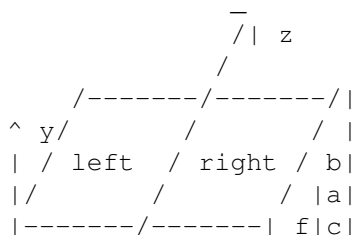
## 1.5 Octree

### OCTREE

Simple raytracers determine the intersections with objects by testing all objects. This can lead to long rendering times if there are a lot of objects in the scene.

One solution of this problem is the Octree algorithm. This algorithm divides the scene in eight child-cells and every child-cell again in eight cells and so on until there are less than one objects in the cell or the maximum depth of the tree is reached.

Division of space with the octree algorithm:



```

|           | r|k|
|      up   | o| /
|-----| n|/
|           | t|
|      down | /  x
|-----| /-->

```

## 1.6 Antialiasing

### ANTIALIASING

RayStorm uses a algorithm called 'Adaptive Supersampling' to do antialiasing. This algorithm cast for each pixel with a high contrast against it's four neighbours new rays which are close to the ray used for the pixel itself. The new color of the pixel is calculated with the supersampled pixels and the gaussian filter.

Supersampling is also used to do depth of field and soft shadows. So if you want to use this features you have to set a antialiasing value greater than one. (-> ANTIALIAS)

Example:

Settings: squareroot of number of samples per pixel: 3

```

|-----|-----|-----|
| super- | super- | super- |
| sampled| sampled| sampled|
|         |         |         |
|-----|-----|-----|
| super- |         | super- |
| sampled| pixel  | sampled|
|         |         |         |
|-----|-----|-----|
| super- | super- | super- |
| sampled| sampled| sampled|
|         |         |         |
|-----|-----|-----|

```

```

|- Gaussian filter width -|

```

The rendering time increases dramatically if you use antialiasing. The values below depend on the contrast of the picture.

Samplesetting	rendering time
1	x1
2	x4
3	x9
4	x16
...	...

Setting higher than 3 are not leading to significant better results.

## 1.7 Depth of field

### DEPTH OF FIELD

Objects in computer graphics are normally rendered in an image plane using a pinhole camera model. That is to say, no matter how far or how near the objects are from the camera, they are always in sharp focus. Depth of field means that only objects at a certain distance from the camera lens are in sharp focus. Further and nearer objects produce a blurred image on the film plane.

[From 'Advanced Animation and Rendering Techniques']

To use depth of field you have to set `ANTIALIAS` to a value bigger than one.

Example for DOF

## 1.8 Soft shadows

### SOFT SHADOWS

Real Light sources never have a zero size, therefore the shadows behind objects are never hard edged, they are soft. RayStorm generates this shadows by jittering the position of the light source. To use soft shadows you have to set `DISTRIB` to a value bigger than one.

## 1.9 Surfaces

### SURFACES

Ambient (set with `AMBIENT`)

This determines the color of the object in sections which are in shadow.

Diffuse reflection (set with `DIFFUSE`)

The diffuse reflection falls off as the cosine of the angle between the normal and the ray to the light. Diffuse reflection determines the main color of the object (color in `Imagine`).

Specularly reflected highlights (set with `SPECULAR`)

Specularly reflected highlights fall off as the cosine of the angle between the reflected ray and the ray to the light source (specular in `Imagine`)

Specular reflection exponent (set with `REFEXP`)

Determines the size of the specularly reflected highlights, the higher the smaller the highlight (hardness in `Imagine`)

---

Diffuse transmission (set with DIFFTRANS)

Same as diffuse reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not 0.

Specular transmission (set with SPECTRANS)

Same as specular reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not 0.

Specular transmission exponent (set with TRANSEXP)

Same as specular reflection exponent, but only used if the lightsource is on opposite side of surface.

Specular transmittance (set with TRANSLUC)

Specular transmittance.

Transparency (set with TRANSPAR)

Transparent color (filter in Imagine).

Reflectivity (set with REFLECT)

Reflective color (reflect in Imagine).

Fog lenght (set with FOGLEN) (fog in Imagine).

Index of refraction (set with REFRINDEX)

Determines how the ray through transparent objects is refracted, the higher the more (index of refraction in Imagine).  
Is calculated with the formula

$$\text{index} = \frac{\text{lightspeed in vacuum}}{\text{lightspeed in object}} .$$

## 1.10 Internals

### INTERNALS

#### Memory requirements

Triangle:	156 Bytes (flat shaded)
	192 Bytes (Phong shaded)
Sphere:	70 Bytes
Plane:	78 Bytes
Surface:	122 Bytes + length of name
Screenbuffer:	4 Bytes per pixel

Memory requirements of the octree depends on the scene.

## 1.11 Virtual Memory

### VIRTUAL MEMORY

RayStorm has been tested successfully with VMM 3.1 from Martin Apel. If you want use RayStorm with virtual memory notice following hints:

- set Minimum VM allocation to 100 bytes if you define large scenes with many objects, because RayStorm only allocates small pieces of memory for single objects (less then 200 bytes). If you're loading Imagine objects RayStorm allocates big blocks of memory so you don't have to set Minimum VM allocation to 100.
- use a partition or a pseudo-partition for VMM, this is faster

## 1.12 Blur

### MOTION BLUR

Motion blur is temporal anti-aliasing. In animated sequences, the normal rendering process functions like a camera that possesses an infinitely short exposure time and this eliminates the blurring of the image due to relative motion between an object and the film plane. When a series of images, generated without motion blur, is displayed as an animated sequence, the illusion of smooth motion is diminished by strobing effects. As human beings we expect to see loss of detail in moving images.

Motion blur is accounted for in distributed ray tracing by extending the distributed sampling and jittering into the time domain and computing a solution that extracts information from the scen over the duration of the shutter exposure time. Objects are moved as required in the time period and visibility consequently changes over this time intervall. This method ensures that highlights and shadows are blurred or not, depending on the nature of the motion.

[From 'Advanced Animation and Rendering Techniques']

## 1.13 Requirements

### REQUIREMENTS

### REQUIREMENTS

- (1) You will need at least Kickstart 2.0.
  - (2) 881-version: 68020 processor and a mathematical coprocessor (68881/882 or internal 68040/060 version).
  - (2) 020-version: 68020 processor (no math coprocessor needed)
  - (4) 000-version: 68000 processor (should even run on a Amiga 500 (not tested))
-

(5) 1MB RAM minimum

(6) RayStorm was written using MUI. So you need muimaster.library V2.3 or better to run RayStorm.

recommended: 68030, 68882, Harddisk, GFX-Board

The faster the better :-).

Tested with:

A1200 68030/50, 6MB, 200MB HD

A2000 68040/30, 9MB, 250+250MB HD, Merlin Gfx-board

A2000 68030/14, 68882/20, 4MB, 730+52MB HD

A4000 68030/25, 68882/57, 10MB, 730+80MB HD, Cybervision 64 Gfx-board

## 1.14 Features

### FEATURES

- Up to 30% faster than Imagine (in trace mode).
- ARexx-port. RayStorm can be used by all programs with ARexx-port.
- Imagine compatible. RayStorm is designed to be almost compatible to Imagine. It can load Imagine objects and use Imagine textures.
- Octree algorithm used for rendering.
- Color, reflectivity, filter, altitude and specular mapping.
- Flat, cylinder and sphere mapping.
- Soft brush mapping.
- Mathematical textures: wood, marble, bumps, checker, linear, radial, stars.
- Transparency and physically correct refractions.
- 8 levels of antialiasing (adaptive supersampling).
- Rendering box.
- Three builtin object types: sphere, plane and triangle.
- Three light types: ambient, point and spot.
- Depth of field with adjustable focal distance and aperture.
- Soft shadows.
- Backdrop picture.
- Global fog and foggy objects.
- Material attributes for realistic objects: ambient color, diffuse color, specular color, specular reflection exponent, diffuse transmission color, specular transmission color, specular transmission exponent, specular transmittance, transparent color, reflective color, index of refraction, foglength.
- Bright objects.
- Motion blur for realistic animations.
- Quick rendering.
- Global reflection map.
- Image formats: IFF-ILBM, PNG, TGA and Datatypes.
- Object format: Imagine-TDDD, Autodesk 3DS
- New image- and object-formats can be easily included because of the modular concept.

## 1.15 Installation

### INSTALLATION

There is a installation script included in the archive which uses the Commodore Installer. Run it to install RayStorm.

## 1.16 ARexx Interface

### AREXX INTERFACE

- Introduction
- Address
- Parameters
- Commands

## 1.17 ARexx Introduction

### AREXX INTRODUCTION

RayStorm is completely controled through it's ARexx interface. We recommend that you have a look at the example script files in the 'ARexx' directory. These examples cover most of the features of RayStorm. We encourage you to create your own files and make them available for the public. You can send them to us and we might add them as an example files in the next version of RayStorm or we include them to our Homepage.  
In one of the next versions of RayStorm we'll create a more powerful language, which has a similar syntax to C++.

It's the same if you write the the commands in upper case or lower case. But it's important to enclose all commans in quotes because ARexx tries to interpret the line before it sends it to ARexx. It may happen that the line is changed and RayStorm don't do this what you want.

A typical structure of a scene file is:

```
/* title, comments, ... */

/* setting resolution, world, camera, lightsources */
'SETSCREEN 160 128'
'SETWORLD [0,0,0] [40,40,40]'
'SETCAMERA <0,0,80> <0,0,0> <0,1,0> 25 20'
'POINTLIGHT <10,-10,100> [255,255,255] SHADOW'

/* define surfaces and actors */
'NEWSURFACE TEST1'
'AMBIENT [255,0,0]'
'DIFFUSE [255,0,0]'
'SPECULAR [255,255,255]'

'NEWSURFACE TEST2'
'AMBIENT [0,0,255]'
```

```
/* creating objects */
'SPHERE TEST1 <0,0,0> 10'
'SPHERE TEST2 <0,0,0> 10'

/* finally start to render the scene */
'STARTRENDER'

/* save the image */
'SAVEPIC "test.iff"'

'CLEANUP'
```

## 1.18 ARexx Address

ADDRESS

The ARexx-address of RayStorm is 'RAYSTORM'.

## 1.19 ARexx Parameters

AREXX PARAMETERS

The parameters of a command can be FLOATs, INTEGERs, VECTORs, COLORs, STRINGs, and IDENTIFIERS.

FLOAT      An FLOAT is a floating point number with single precision

NUMBER     A NUMBER is a simple integer number

VECTOR     A VECTOR is embedded in '<' '>' and consists of three FLOATs

COLOR      A COLOR is embedded in '[' ']' and consists of three INTEGERs with a range of 0 to 255

STRING     A STRING consists of characters

KEYWORD    An KEYWORD is a switch and consists of uppercase characters

PARAMETER CONVENTIONS

/S - Switch.

/N - Number.

/A - Required.

All other numeric parameters are floating point numbers.

## 1.20 ARexx Commands

---

## AREXX COMMANDS

- General
- Objects
- Attributes
- Animation
- Errors

Alphabetically sorted

- A-
  - ALIGNMENT
  - AMBIENT
  - ANTIALIAS
- B-
  - BRUSH
  - BRUSHPATH
- C-
  - CLEANUP
- D-
  - DIFFTRANS
  - DIFFUSE
  - DISPLAY
  - DISTRIB
- F-
  - FOGLEN
- G-
  - GETERRORSTR
- I-
  - IMTEXTURE
- L-
  - LOADOBJ
- N-
  - NEWSURFACE
- O-
  - OBJECTPATH
- P-
  - PLANE
  - POINTLIGHT
  - POSITION
- Q-
  - QUIT
- R-
  - REFEXP
  - REFLECT
  - REFRINDEX
- S-
  - SAVEPIC
  - SETCAMERA
  - SETSCREEN
  - SETWORLD
  - SIZE
  - SPECTRANS
  - SPECULAR
  - SPHERE
  - SPOTLIGHT

---

```

STARTRENDER
-T-
TEXTUREPATH
TRANSEXP
TRANSLUC
TRANSPAR
TRIANGLE
-W-
WINTOFRONT

```

## 1.21 General ARexx-commands

### GENERAL AREXX-COMMANDS

ANTIALIAS	sets antialiasing parameters
BRUSHPATH	sets brush path
CLEANUP	cleanups scene
DISPLAY	displays scene
DISTRIB	sets parameters for distributive sampling
GETERRORSTR	gets a error string for a given number
OBJECTPATH	sets object path
POINTLIGHT	creates point lightsource
QUIT	quits RayStorm
SAVEPIC	saves rendered picture
SETCAMERA	sets camera parameters
SETSCREEN	sets screen parameters
SETWORLD	sets world parameters
SPOTLIGHT	creates spot lightsource
STARTRENDER	starts rendering
TEXTUREPATH	sets texture path
WINTOFRONT	brings window to front

## 1.22 antialias

### ANTIALIAS

#### Template:

SAMPLES/N/A,WIDTH,CONTRIB

#### Arguments:

NUMBER SAMPLES

squareroot of number of samples per pixel (max. 8)

FLOAT WIDTH

width of gaussian filter

COLOR CONTRIB

max. allowed contrast

#### Description:

Sets antialiasing parameters (see Antialiasing)

#### Default:

ANTIALIAS 1 1.3 [51,38,76]

## 1.23 brushpath

BRUSHPATH

Template:

PATH/A

Arguments:

STRING PATH

pathname (format: 'path1;path2;...;pathn')

Description:

Defines the path where to search brushes.

## 1.24 cleanup

CLEANUP

Template:

none

Arguments:

none

Description:

Deletes all defined objects, lightsources, surfaces and actors

## 1.25 display

DISPLAY

!!! CAUTION !!!

THIS COMMAND ISN'T RELEASED IN THIS VERSION YET

!!! CAUTION !!!

Template:

FLOYD/S

Arguments:

KEYWORD FLOYD/S

dither with Floyd-Steinberg algorithm

Description:

Displays rendered pic on screen

## 1.26 distrib

DISTRIB

Template:

SAMPLES/N,SOFTSHADOW/N

Arguments:

NUMBER SAMPLES/N

squareroot of number of samples per pixel for motionblur

NUMBER SOFTSHADOW/N

---

squareroot of number of samples per pixel for softshadows

Description:  
Sets number of samples per pixel for distributive sampling (used for  
and )

Default:  
DISTRIB 1,1

## 1.27 geterrorstr

GETERRORSTR

Template:  
ERRNUM/N/A

Arguments:  
NUMBER ERRNUM  
error number

Description:  
Returns the error string for the given error number

## 1.28 objectpath

OBJECTPATH

Template:  
PATH/A

Arguments:  
PATH  
pathname (format: 'path1;path2;...;pathn')

Description:  
Defines the path where to search Imagine objects.

## 1.29 pointlight

POINTLIGHT

Template:  
POS,COLOR,SIZE,SHADOW/S,ACTOR,FALLOFF

Arguments:  
VECTOR POS  
position  
COLOR COLOR  
color of light  
VECTOR SIZE  
size of light source (used for soft shadows)  
KEYWORD SHADOW/S  
cast shadows if keyword given  
STRING ACTOR  
name of actor  
FLOAT FALLOFF  
distance where the brightness of the light is zero

**Description:**

Creates a point lightsource

**Default:**

POINTLIGHT <0,0,0> [255,255,255] 0 ?? ?? 0

## 1.30 quit

QUIT

**Template:**

none

**Arguments:**

none

**Description:**

Quits Raystorm

## 1.31 savepic

SAVEPIC

**Template:**

NAME/A,FORMAT

**Arguments:**

STRING NAME

name of file to save

STRING FORMAT

image format (default ILBM)

**Description:**

Saves rendered picture. If an error occurs the command returns an error string.

## 1.32 setcamera

SETCAMERA

**Template:**

POS/A,VIEWPOINT,VIEWUP,FOVX,FOVY,FOCALDIST,APERTURE,POSACTOR,VIEWACTOR

**Arguments:**

VECTOR POS

position

VECTOR VIEWPOINT

viewpoint

VECTOR VIEWUP

viewupvector

FLOAT FOVX, FOVY

field of view (in degree) (20 degree creates camera like Imagine default camera)

FLOAT FOCALDIST

distance from eye to focal plane

FLOAT APERTURE

aperture width (0 = pinhole) (-> depth of field)  
STRING POSACTOR  
name of position actor  
STRING VIEWACTOR  
name of point of view actor  
Description:  
Sets the parameters of the camera  
Default:  
SETCAMERA <0,0,-10> <0,0,0> <0,1,0> 45 45 1. 0.

### 1.33 setscreen

SETSCREEN

Template:  
RESX/N/A, RESY/N/A, COLORS/N

Arguments:  
NUMBER RESX, RESY  
resolution  
NUMBER COLORS  
number of colors (not yet implemented)

Description:  
Sets the screen parameters. Note that in the demo-version the resolution is limited to 160x128!

Default:  
SETSCREEN 128 128 32

### 1.34 setworld

SETWORLD

Template:  
BACK/A, AMBIENT, RANDJIT/S, BACKDROP, FOGLEN, FOGHEIGHT, FOGCOLOR, REFLMAP

Arguments:  
COLOR BACK  
backgroundcolor  
COLOR AMBIENT  
ambientcolor  
KEYWORD RANDJIT  
use random jitter for depth of field and soft shadows  
STRING BACKDROP  
name of backdrop picture  
FLOAT FOGLEN  
global fog length  
FLOAT FOGHEIGHT  
highest fog y-coordinate  
COLOR FOGCOLOR  
fogcolor  
STRING REFLMAP  
name of reflection map

Description:  
Sets world parameters

---

Default:

```
SETWORLD [0,0,0] [0,0,0] ?? 32 0 [255,255,255]
```

## 1.35 spotlight

SPOTLIGHT

Template:

```
POS,COLOR,LOOKPOINT,ANGLE,SIZE,SHADOW/S,ACTOR,LOOKP_ACTOR,FALLOFF
```

Arguments:

```
VECTOR POS
```

```
    position
```

```
COLOR COLOR
```

```
    color
```

```
VECTOR LOOKPOINT
```

```
    lookpoint
```

```
FLOAT ANGLE
```

```
    opening angel (in degree max. 180)
```

```
FLOAT SIZE
```

```
    size of light source (used for soft shadows)
```

```
KEYWORD SHADOW
```

```
    cast shadows if keyword given
```

```
STRING ACTOR
```

```
    name of position actor
```

```
STRING LOOKP_ACTOR
```

```
    name of lookpoint actor
```

```
FLOAT FALLOFF
```

```
    distance where the brightness of the light is zero
```

Description:

Creates a spot lightsource. The rays emitted from a spotlight are constrained by a cone. The LOOKPOINT vector gives the center of the illuminated area.

Default:

```
SPOTLIGHT <0,0,0> [255,255,255] <0,0,1> 45 0 ?? ?? ?? 0
```

## 1.36 startrender

STARTRENDER

Template:

```
QUICK/S,DEPTH/N,FROM,TO/N,LEFT/N,TOP/N,RIGHT/N,BOTTOM/N
```

Arguments:

```
KEYWORD QUICK
```

```
    render quick (no shadows, reflections and transparency)
```

```
NUMBER DEPTH
```

```
    depth of generated octree (default 3)
```

```
FLOAT FROM,TO
```

```
    time code (default 0,0). If you want motion blur you have to
    set FROM and TO to different values, if not only set FROM.
```

```
NUMBER LEFT,TOP,RIGHT,BOTTOM
```

```
    coordinates for rendering box. Picture is renderd only inside of
    rectangle.
```

**Description:**

Starts rendering process. If you set QUICK shadows, reflections and transparency are not calculated. In very complex scenes it is useful to increase the octree depth in order to reach a better performance during the rendering process. But this can only be done with enough memory!

## 1.37 texturepath

TEXTUREPATH

**Template:**

PATH/A

**Arguments:**

PATH

pathname (format: 'path1;path2;...;pathn')

**Description:**

Defines the path where to search textures.

## 1.38 wintofront

WINTOFRONT

**Template:**

none

**Arguments:**

none

**Description:**

Brings RayStorm window in front

## 1.39 ARexx-commands for creating objects

AREXX-COMMANDS FOR CREATING OBJECTS

LOADOBJ loads an Imagine TDDD-file  
PLANE creates a plane (ground in Imagine)  
SPHERE creates a sphere  
TRIANGLE creates a triangle

## 1.40 loadobj

LOADOBJ

**Template:**

NAME/A, POS, ALIGN, SCALE, ACTOR, SURFACE

**Arguments:**

STRING NAME

filename

---

VECTOR POS  
     position  
 VECTOR ALIGN  
     alignment (in degrees)  
 VECTOR SCALE  
     scaling  
 STRING ACTOR  
     name of actor  
 STRIGN SURFACE  
     name of surface to replace object surface

Description:

Loads an

- Imagine TDDD-file  
    loads attributes, triangles (with correct handling of sharp edges),  
    perfect spheres, planes, brushes and textures
- 3DS file  
    loads attributes, triangles and generates sharp edges

Where to get Imagine object files?

Look on FTP-servers which support AMINET. For example try out

ftp.uni-paderborn.de

Path: ftp/aminet/pub/gfx/3dobj/

Default:

LOADOBJ ??? <0,0,0> <0,0,0> <1,1,1>

## 1.41 plane

PLANE

Template:

SURF/A, POS, NORM, ACTOR

Arguments:

STRING SURF

    surface name

VECTOR POS

    position

VECTOR NORM

    normal

STRING ACTOR

    name of actor

Description:

Creates a infinite plane

Default:

PLANE ??? <0,0,0> <0,1,0>

## 1.42 sphere

SPHERE

Template:

SURF/A, POS/A, RADIUS/A, ACTOR

Arguments:  
STRING SURF  
    surface name  
VECTOR POS  
    position  
FLOAT RADIUS  
    radius  
STRING ACTOR  
    name of actor  
Description:  
Creates a sphere

## 1.43 triangle

TRIANGLE

Template:  
SURF/A,P1/A,P2/A,P3/A,N1,N2,N3,ACTOR

Arguments:  
STRING SURF  
    surface name  
VECTOR P1  
    first point  
VECTOR P2  
    second point  
VECTOR P3  
    third point  
VECTOR N1  
    first normal  
VECTOR N2  
    second normal  
VECTOR N3  
    third normal  
STRING ACTOR  
    name of actor

Description:  
Creates a triangle with corners at position P1, P2 and P3. If you specify the normals, a phong shaded triangle otherwise a flat triangle is created. Computing the normals by hand is a difficult task, and should be done by utility programs.

## 1.44 ARexx-commands for setting attributes

AREXX-COMMANDS FOR SETTING ATTRIBUTES

Every object must have a surface definition. With the following commands you can set the attributes of a surface. First you have to define the current surface with 'NEWSURFACE <name>'. Raystorm will set the attributes of the new surface to default values. Every following command such as AMBIENT or DIFFTRANS refers to the current surface and will override the corresponding default values.

---

The following examples define two surfaces:

```
NEWSURFACE RED
AMBIENT [255,0,0]
DIFFUSE [255,0,0]
```

```
NEWSURFACE WATER
DIFFUSE [0,0,255]
REFRINDEX 1.333
```

List of surface commands:

```
NEWSURFACE  creates a new surface
AMBIENT      sets ambient color
BRUSH        adds a brush
DIFFTRANS    sets diffuse transmission color
DIFFUSE      sets diffuse color
FOGLEN       sets the foglength
IMTEXTURE    adds a Image texture
REFEXP       sets the specular reflection exponent
REFLECT      sets the specular reflectivity
REFRINDEX    sets the index of refraction
SPECTRANS    sets the specular transmission
SPECULAR     sets the specular color
TRANSEXP     sets the specular transmission exponent
TRANSLUC     sets the specular transmittance
TRANSPAR     sets the diffuce transmittance
```

## 1.45 ambient

AMBIENT

Template:

COLOR/A

Arguments:

STRING COLOR  
color

Description:

Sets the ambient color of surface

Default:

AMBIENT [255,255,255]

## 1.46 brush

BRUSH

Template:

NAME/A, TYPE/A, WRAP/A, POS/A, ALIGN/A, SIZE/A, REPEAT/S, MIRROR/S, SOFT/S, ACTOR

Arguments:

STRING NAME  
name of brush file  
KEYWORD TYPE [COLOR|REFLECT|FILTER|ALTITUDE|SPECULAR]  
Brush type

KEYWORD WRAP [FLAT|WRAPX|WRAPY|WRAPXY]  
Brush wrapping method  
VECTOR POS  
position  
VECTOR ALIGN  
alignment  
VECTOR SIZE  
size of brush  
KEYWORD REPEAT  
if set brush is repeated like a tile  
KEYWORD MIRROR  
if set brush is mirrored  
KEYWORD SOFT  
if set brush color is softly interpolated  
STRING ACTOR  
name of actor

Description:

Adds a brush to surface. A brush is a bitmap which is wrapped around an object. The specified file will be searched for in the current directory. If not found and a brushpath is given, the file will be searched there. If an error occurs the command returns an error string. Supported formats are: IFF-ILBM, PNG, TGA and Datatypes.

Constants for type:

COLOR  
Replaces the surface color of the object with the image (sets DIFFUSE and AMBIENT).  
REFLECT  
Map covers the surface and reflects environment (see REFLECT)).  
FILTER  
Uses the white color to pass colors and the black area to hold back color with a variance between two colors (see TRANSPAR).  
ALTITUDE  
The red values of the brush are used to give the surface an appearance of bumpiness.  
SPECULAR  
The rgb values set the specular color of the surface (see SPECULAR).

Constants for wrap :

FLAT  
The brush is projected to X-Y plane, the axis is in the middle of the brush area, length is the distance from the middle to the border.  
WRAPX  
The brush is wrapped around the x-axis, like on a cylinder. The left edge of the brush begins at the positive X axis and wraps the brush around the cylinder from 'west' to 'east'.  
WRAPY  
Same as WRAPX, but wrapping is around the y-axis.  
WRAPXY  
Wrapping both: around X and Y axis. It is assumed, that the object is a sphere. The Y axis is the north/south pole of the spherical mapping. The left edge of the brush begins at the positive X axis and wraps the brush around the sphere from 'west' to 'east'. The brush covers the sphere exactly once.

---

## 1.47 difftrans

DIFFTRANS

Template:

COLOR/A

Arguments:

COLOR COLOR  
color

Description:

Sets the diffuse transmission color of surface. Same as diffuse reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not set to zero.

Default:

DIFFTRANS [0,0,0]

## 1.48 diffuse

DIFFUSE

Template:

COLOR/A

Arguments:

COLOR COLOR  
color

Description:

Sets the diffuse color of surface. The diffuse reflection falls off as the cosine of the angle between the normal and the ray to the light. Diffuse reflection determines the main color of the object (color in Imagine).

Default:

DIFFUSE [255,255,255]

## 1.49 foglen

FOGLEN

Template:

VALUE/A

Arguments:

FLOAT VALUE/A  
foglength

Description:

Sets the foglength of the surface. Fog color is set with TRANSPAR.

Default:

FOGLEN 0

## 1.50 imtexture

## IMTEXTURE

### Template:

NAME/A, POS, ALIGN, SIZE, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, ↵  
ACTOR

### Arguments:

STRING NAME

name of Imagine texture file

VECTOR POS

position

VECTOR ALIGN

alignment

VECTOR SIZE

size of texture axis

FLOAT P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16

texture parameters

STRING ACTOR

name of actor

### Description:

Adds a Imagine texture to surface

### Default:

defaults are taken from texture if not all paramters are given

## 1.51 newsurface

### NEWSURFACE

#### Template:

NAME/A, BRIGHT/S

#### Arguments:

STRING NAME

name

KEYWORD BRIGHT

if set the brightness of the surface is everywhere the same

#### Description:

Creates a new surface with name 'NAME'

## 1.52 refexp

### REFEXP

#### Template:

VALUE/A

#### Arguments:

FLOAT VALUE

specular reflection exponent

#### Description:

Sets the specular reflection exponent of surface. Determines the size of the specularly reflected highlights, the higher the smaller the highlight (hardness in Imagine).

#### Default:

REFEXP 12.

## 1.53 reflect

REFLECT

Template:

COLOR/A

Arguments:

COLOR COLOR  
color

Description:

Sets the specular reflectivity of surface

Default:

REFLECT [0,0,0]

## 1.54 refrindex

REFRINDEX

Template:

VALUE/A

Arguments:

FLOAT VALUE  
index of refraction

Description:

Sets the index of refraction of surface. Determines how the ray is refracted through transparent objects, the higher the more (index of refraction in Imagine).

Default:

REFRINDEX 1.

Examples:

MATERIAL	Index
-----	
Vacuum .....	1.00000 (exactly)
Air (STP) .....	1.00029
Acetone .....	1.36
Alcohol .....	1.329
Amorphous Selenium .....	2.92
Calspar1 .....	1.66
Calspar2 .....	1.486
Carbon Disulfide .....	1.63
Chromium Oxide .....	2.705
Copper Oxide .....	2.705
Crown Glass .....	1.52
Crystal .....	2.00
Diamond .....	2.417
Emerald .....	1.57
Ethyl Alcohol .....	1.36
Flourite .....	1.434
Fused Quartz .....	1.46
Heaviest Flint Glass .....	1.89
Heavy Flint Glass .....	1.65
Glass .....	1.5
Ice .....	1.309

Iodine Crystal .....	3.34
Lapis Lazuli .....	1.61
Light Flint Glass .....	1.575
Liquid Carbon Dioxide .....	1.20
Polystyrene .....	1.55
Quartz 1 .....	1.644
Quartz 2 .....	1.553
Ruby .....	1.77
Sapphire .....	1.77
Sodium Chloride (Salt) 1 ....	1.544
Sodium Chloride (Salt) 2 ....	1.644
Sugar Solution (30%) .....	1.38
Sugar Solution (80%) .....	1.49
Topaz .....	1.61
Water (20 C) .....	1.333
Zinc Crown Glass .....	1.517

## 1.55 spectrans

SPECTRANS

Template:

COLOR/A

Arguments:

COLOR COLOR

color

Description:

Sets the specular transmission color of surface. Same as specular reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not 0.

Default:

SETSPECTRANS [255,255,255]

## 1.56 specular

SPECULAR

Template:

COLOR/A

Arguments:

COLOR COLOR

color

Description:

Sets the specular color of surface. Specularly reflected highlights fall off as the cosine of the angle between the reflected ray and the ray to the light source (specular in Imagine).

Default:

SPECULAR [255,255,255]

## 1.57 transexp

TRANSEXP

Template:

VALUE/A

Arguments:

FLOAT VALUE

specular transmission exponent

Description:

Sets the specular transmission exponent of surface. Same as specular reflection exponent, but only used if the lightsource is on opposite side of surface.

Default:

TRANSEXP 12.

## 1.58 transluc

TRANSLUC

Template:

VALUE/A

Arguments:

FLOAT VALUE

specular transmittance

Description:

Sets the specular transmittance of surface

Default:

TRANSLUC 0

## 1.59 transpar

TRANSPAR

Template:

COLOR/A

Arguments:

COLOR COLOR

color

Description:

Sets the diffuse transmittance of surface

Default:

TRANSPAR [0,0,0]

## 1.60 ARexx-commands for animation control

AREXX-COMMANDS FOR ANIMATION CONTROL

ALIGNMENT sets alignment

NEWACTOR creates a new actor

POSITION sets position

SIZE sets size

## 1.61 alignment

ALIGNMENT

Template:

FROM/A, TO/A, ALIGN/A, TYPE

Arguments:

FLOAT FROM, TO

time code

VECTOR ALIGN

alignment at time 'TO'

KEYWORD TYPE [LINEAR]

interpolation type (currently only linear)

Description:

Sets the alignment of the object. 'TYPE' can be one of the following identifiers:

LINEAR the interpolation is done in a straight way.

SPLINE the interpolation is done in a spline curve way. (NOT IMPLEMENTED YET)

## 1.62 newactor

NEWACTOR

Template:

NAME/A, POS, ALIGN, SIZE

Arguments:

STRING NAME

name of new actor

VECTOR POS

axis position

VECTOR ALIGN

axis alignment (in degrees)

VECTOR SIZE

axis size

Description:

Creates a new actor

Default:

NEWACTOR ??? <0,0,0> <0,0,0> <1,1,1>

## 1.63 position

POSITION

Template:

FROM/A, TO/A, POS/A, TYPE

Arguments:

FLOAT FROM, TO

time code

VECTOR POS

position at time 'TO'

KEYWORD TYPE [LINEAR]

---

interpolation type (currently only linear)

Description:

Sets the position of the object. 'TYPE' can be one of the following identifiers:

LINEAR the interpolation is done in a straight way.  
 SPLINE the interpolation is done in a spline curve way. (NOT IMPLEMENTED YET)

## 1.64 size

SIZE

Template:

FROM/A, TO/A, SIZE/A, TYPE

Arguments:

FLOAT FROM, TO  
 time code  
 SIZE  
 size at time 'TO'  
 KEYWORD TYPE [LINEAR]  
 interpolation type (currently only linear)

Description:

Sets the size of the object. 'TYPE' can be one of the following identifiers:

LINEAR the interpolation is done in a straight way.  
 SPLINE the interpolation is done in a spline curve way. (NOT IMPLEMENTED YET)

## 1.65 ARexx-errors

AREXX-ERRORS

These values are returned when something went wrong, you can get the error string with the command GETERRORSTR.

Application and parser errors

Here are the errors returned from the command parser and the application itself.

- 10 Wrong screen resolution  
Both components of the screen resolution have to be higher than one.
- 11 Actor not defined  
The specified actor name does not exist.
- 12 Surface not defined  
The specified surface name does not exist.
- 13 Not enough memory  
Allocation of memory failed.
- 14 Limitations of demo version reached  
The demo version is limited to a resolution of 160x128.
- 15 Unknown brush mapping type  
You specified a unknown mapping method for the BRUSH command.

- 16 Unknown brush wrapping method  
You specified a unknown wrapping method for the BRUSH command.
- 17 Depth of octree too big (max. 6)  
The octree depth is limited to a depth of 6.
- 18 Invalid time intervall  
One component of a time intervall was negative or the beginning time was later than the end.
- 19 Antialiasing value too big (max. 8)  
The value of the ANTIALIAS command is limited to 8.
- 20 Distribution value too big (max. 8)  
The value of the DISTRIB command is limited to 8.
- 21 Unknown interpolation method  
You specified a unknown interpolation method for the POSITION, ALIGNMENT or SIZE command.
- 22 No picture renderd  
There is no picture for SAVEPIC to save because you renderd none or called CLEANUP before.
- 23 Can't open screen  
The DISPLAY command was unable to open the screen  
(!!! THIS COMMAND ISN'T RELEASED IN THIS VERSION YET !!!).
- 24 Can't open iffparse.library  
RayStorm failed to open iffparse.library (at least version 37 is needed)
- 25 Can't open graphics.library  
RayStorm failed to open graphics.library (at least version 33 is needed)
- 26 Can't open intuition.library  
RayStorm failed to open intuition.library (at least version 37 is needed)
- 27 Can't open window  
RayStorm failed to open the window.
- 28 Can't open muimaster.library  
RayStorm failed to open muimaster.library (at least version 8 is needed)
- 29 Invalid vector definition  
The specified vector has the wrong format (must be '<x,y,z>').
- 30 Invalid color definition  
The specified color has the wrong format (must be '[r,g,b]').
- 31 Invalid region definition  
The specified region is out of range.

#### Internal errors

This are errors of the renderer.

- 101 Not enough memory  
Allocation of memory failed.
  - 102 Error in triangle definition  
It's impossible to generate a triangle with the specified coordinates (see TRIANGLE).
  - 103 The view and up directions are identical?  
You specified a view-up-vector for the CAMERA command which is identical to the view direction.
  - 104 Not enough memory for screen buffer  
The allocation of the screen buffer failed.
  - 105 The backdrop picture has the wrong size  
The backdrop picture must have the same resolution as the with
-

SETSCREEN specified screen resolution.

106 Can't open Image texture file  
RayStorm failed to open the specified Image texture file, check filename and path.

107 Can't open brush file  
RayStorm failed to open the specified brush file, check filename and path.

108 Error initializing Image texture  
An error occurred as RayStorm tried to initialize a Image texture.

109 Can't open picture  
RayStorm failed to open the specified picture file, check filename and path.

110 Error reading picture  
An error occurred while RayStorm read a picture file.

111 Can't open picture type file ('modules/picture/types')  
RayStorm failed to open the typefile. The typefile is needed to identify the filetypes of the pictures. RayStorm was unable to open the file 'modules/picture/types'.

112 Error reading picture type file  
An error occurred while RayStorm read the picture type file, maybe the file is damaged.

113 Unknown picture format  
RayStorm was unable to recognize the format of the picture file.

114 An error occurred while invoking picture handler  
The used picture handler returned a error.

115 Can't open object  
RayStorm failed to open the specified object file, check filename and path.

116 Error reading object  
An error occurred while RayStorm read a object file.

117 Can't open object type file ('modules/object/types')  
RayStorm failed to open the typefile. The typefile is needed to identify the filetypes of the objects. RayStorm was unable to open the file 'modules/object/types'.

118 Error reading object type file  
An error occurred while RayStorm read the object type file, maybe the file is damaged.

119 Unknown object format  
RayStorm was unable to recognize the format of the object file.

120 An error occurred while invoking object handler  
The used object handler returned a error.

## 1.66 Examples

### EXAMPLES

We have included several demos in the directories 'rexx' and 'examples' to show how to use RayStorm.

In the 'arexx' directory are examples scripts which show the usage of RayStorm with ARExx. Start them simply by typing 'rx ??? ray' in a shell (??? ray is the name of the script).

Attrtest ray

Several examples for attributes.

---

Attrtest1.ray

Several examples for attributes.

Backdrop.ray

Demonstrates usage of backdrop picture.

Bounce.ray

Tutorial.

Brush.ray

Demonstrates usage of brush mapping.

Bump.ray

Test of bump texture.

Checker.ray

Test of checker texture.

Chess.ray

Chess scene.

Coin.ray

Jumping coin with motion blur.

Dof.ray

Test of depth of field.

Dolphins.ray

Three dolphins with light effect.

Eight.ray

Billard scene.

Fog.ray

Fog demonstration.

Fogl.ray

Fog demonstration.

Im\_texture.ray

Example for usage of Imagine textures.

Logo.ray

Renders the RayStorm logo.

Marble.ray

Test of marble texture.

Randomsphere.ray

Randomly colored sphere.

Simple.ray

Tutorial.

Sun.ray

Sun behind a Planet with simulated lens flares.

Supersample.ray  
Demonstrates adaptive supersampling.

Textures.ray  
Demonstrates textures.

Wood.ray  
Test of wood texture.

In the 'examples' directory are C-programs which show the usage of RayStorm directly with a program. They can only be run from a shell. These programs are producing a couple of pictures no animation, which must be glued together with a utility like MainActor.

Sphanim

Animation of several spheres which jump over a checker board. Camera follows them.

Worldanim

Rotating world.

## 1.67 Tutorials

TUTORIALS

Simple scene  
Bouncing ball

## 1.68 Simple scene

Tutorial: Simple scene

Now we will create a very famous scene. A sphere over a checkerboard! This might be boring, but it's good for the absolute beginner to get an impression of building a scene.

Here we go:

1. In the drawer 'ARexx' of the RayStorm directory there is a file named 'default.ray'. This is a default form for RayStorm ARexx scripts. You can use this form to write your own scripts.  
We'll use this file as a default for our animation script. Copy this file to the file 'simple.ray'. After this load the file 'simple.ray' to your favorite text editor (e.g GoldEd or CygnusEd).
2. To view the scene, we need a camera. Insert after the line 'address RAYSTORM' the line:

```
'SETCAMERA <6,1.5,-1.5> <0,0,0> <0,1,0>'
```

This sets the camera to position  $\langle 6, 1.5, -1.5 \rangle$ . The camera points to  $\langle 0, 0, 0 \rangle$  and the view-up vector is  $\langle 0, 1, 0 \rangle$ . Note that you don't have to specify every single parameter. Every command has default values. Refer to the description of a command to find out the default values.

3. Nothing can be seen without a lightsource.  
Go to the next line and type:

```
'POINTLIGHT <0,50,0> [255,255,255] SHADOW'
```

The sphere is illuminated from above with white light.

4. Before placing the objects in the scene, you have to define their surfaces.  
Insert this line:

```
'NEWSURFACE planesurf'
```

This creates a surface with name planesurf. The plane has a checkered surface, so insert:

```
'IMTEXTURE /textures/checker.itx <0.1,0.1,0.1> <0,0,0> <2,2,2>'
```

5. That was the plane texture. Let 's go over to sphere texture.  
Add:

```
'NEWSURFACE spheresurf'
```

The sphere has a mirrored surface. To simulate a perfect mirror, type

```
'REFLECT [255,255,255]'
```

6. Now we can add the objects to the scene:

```
'SPHERE spheresurf <0,0.5,0> 1'
```

This creates a sphere on position  $\langle 0, 0.5, 0 \rangle$  and radius 1.  
Add the plane:

```
'PLANE planesurf'
```

The default values for the position and the normal vector fit to our scene, so we can take them over.

7. Let's make an end to the definitions and render the scene!  
Type:

```
'STARTRENDER'
```

8. Finally we may not forget to save the picture, so add:

```
'SAVEPIC simple.iff'
```

which will save the rendered picture in the current directory as a IFF-ILBM file.

The last step is to free all the memory with the command 'CLEANUP'. Add:

---

CLEANUP'

9. Start the script from a shell-window with the sequence 'rx simple.ray'. RayStorm will now generate your picture. When RayStorm finished the work start your favourite viewer-program, load the file and have a look at it.

Looks very monochrome!!

To make the world colorful, we make a red checker and set the sky to blue. A blue sky can be done by setting the world's background color.

10. Before 'SETCAMERA' insert:

```
'SETWORLD [30,30,255]'
```

Add

```
'DIFFUSE [155,0,0]'
```

to the surface planesurf (this defines one checker color), the other one must be set in the 'IMTEXTURE' command, so change it to

```
'IMTEXTURE /textures/checker.itx <0.1,0.1,0.1> <0,0,0> <2,2,2> 255 0 0'
```

(Note that '255 0 0' describes a color, but is not embedded in < >, because the checker color belongs to the texture parameters which are all floats.)

11. Render the scene once again, and view it.

That's the end of the tutorial! Make some changes to the scene file and play around with the parameters to see their effects.

## 1.69 Bouncing ball

Tutorial: Bouncing ball

The goal of this tutorial is to show you how to generate little animations. At the end of this tutorial you'll have a animation where the earth rotates and bounces on a rotating plane with a white checker texture on the top and a red checker on the bottom. If you have a fast computer you can also generate the animation with motion blur.

O.k. here we go:

1. In the drawer 'ARexx' of the RayStorm directory there is a file named 'default.ray'. This is a default form for RayStorm ARexx scripts. You can use this form to write your own scripts.  
We will use this file as a default for our animation script. Copy this file to the file 'bounce.ray'. After this load the file 'bounce.ray' to your favorite text editor (e.g GoldEd or CygnusEd).
2. First we define some values: the acceleration of the ball and the amount of frames to generate.  
RayStorm has three commands to set the paths where it searches the files it needs. We use a brush for the surface of the ball and a texture for

the surface of the ground.

To do this we have to insert after the command 'ADDRESS RAYSTORM' the lines:

```
g = .2
frames = 17

'BRUSHPATH /brushes'
'TEXTUREPATH /textures'
```

It's the same if you write the commands in upper case or lower case. But it's important to enclose all commands in quotes because ARexx tries to interpret the line before it sends it. It may happen that the line is changed and RayStorm don't do the things you want.

3. Next we set the screen resolution. For the first experiments we choose a low resolution of 160x128 pixels. Insert the line:

```
'SETSCREEN 160 128'
```

4. Now we set the camera parameters. The first three values determine the position of the camera. We want to place it so that we can see the ball all over the time. The next values set the viewpoint of the camera, this is the point the camera aims to. The next values determine the view up vector. And the last two values determine the field of view. To get a pixel aspect of 1:1 we have to set them to 25 and 20 degree.

```
'SETCAMERA <0,10,40> <0,5,0> <0,1,0> 25 20'
```

5. We want to have a bright blue background for our animation. The background and the global ambient color is set with the 'SETWORLD' command. We want to set the ambient color to a dark gray, if this color is too bright the scene will look washed out and the objects appear flat. Insert the line:

```
'SETWORLD [10,30,200] [10,10,10]'
```

6. The illumination is an important part of a scene. We want to place a pointlight near the camera. Add the line:

```
'POINTLIGHT <5,10,50>'
```

7. Now we define the actor for the plane. We want to rotate it around the Z-axis. Insert the lines:

```
'NEWACTOR groundactor'
'ALIGNMENT 0 ' frames+2 ' <0,0,360>'
```

7. Now we define the surface for the plane and the plane itself. We make it a little reflective and apply a checker texture. The surface 'groundtop' is for the top of the plane and the surface 'groundbottom' is for the bottom of the surface. The plane itself consists of four triangles. Two for the top and two for the bottom. Insert the lines:

```
'NEWSURFACE groundtop'
'DIFFUSE [255,255,255]'
'SPECULAR [0,0,0]'
```

---

```
'REFLECT [50,50,50]'
'IMTEXTURE checker.itx <0,-1,0> <0,0,0> <10,10,10> ACTOR groundactor'

'NEWSURFACE groundbottom'
'DIFFUSE [255,0,0]'
'SPECULAR [0,0,0]'
'REFLECT [50,50,50]'
'IMTEXTURE checker.itx <0,-1,0> <0,0,0> <1.5,1.5,1.5> ACTOR groundactor'

'TRIANGLE groundtop <-2,0,-2> <2,0,-2> <2,0,2> ACTOR groundactor'
'TRIANGLE groundtop <-2,0,-2> <-2,0,2> <2,0,2> ACTOR groundactor'
'TRIANGLE groundbottom <-2,-.01,-2> <2,-.01,-2> <2,-.01,2> ACTOR groundactor'
'TRIANGLE groundbottom <-2,-.01,-2> <-2,-.01,2> <2,-.01,2> ACTOR groundactor'
```

8. Next we define the motion of the ball. It starts at a height of 10 and accelerates until it bounces on the plane, changes it's direction and the motions ends as the ball is back at he start point. Additional the ball rotates around the Y-axis. Add the following sequence to your script:

```
speed = -g
pos = 10
'NEWACTOR ballactor <0,'pos',0>'
do i=0 to frames
  'POSITION ' i i+1 '<0,'pos',0>'
  pos = pos+speed
  if pos<=1 & speed<0 then
    speed = -speed
  else
    speed = speed-g
  end
'ALIGNMENT 0 ' frames+2 ' <0,360,0>'
```

9. Now we define the surface for the ball and the ball itself. The only thing we must do is to map a earth styled brush map to a sphere. To reach this goal the position of the brush must be set to the middle of the sphere and the size must be small enough to be completely inside the sphere. This are the lines to define the ball:

```
'NEWSURFACE ball'
'BRUSH earth.iff COLOR WRAPXY <0,10,0> <0,0,0> <.1,.1,.1> ACTOR ballactor'

'SPHERE ball <0,10,0> 1 ACTOR ballactor'
```

10. If your computer is fast enough you can insert the follwing lines:

```
'ANTIALIAS 2'
'DISTRIB 2'

'ANTIALIAS' improves the quality of the picture; 2 or 3 are normal values,
higher values don't improve the quality significant.
A value higher than one for 'DISTRIB' switches {"motion blur" link Motion Blur} ↔
on.
```

11. At this the we have finished the definitions and now can render the single frames. If youn want the reflections of the ball on the plane you have to delete the keyword 'QUICK', because RayStorm renders no reflections in quick mode. The frame time is set with 'FROM' and 'TO'. We save the frames

as IFF-ILBM pictures with the names 'bounce0001.iff' ... 'bounceXXXX.iff'. The last step is to free all the memory with the command 'CLEANUP'. Add these lines:

```
do i=0 to frames
  'STARTRENDER QUICK FROM 'i' TO 'i+1
  'SAVEPIC bounce' || RIGHT(i,4,0) || '.iff'
end

'CLEANUP'
```

12. Start the script from a shell-window with the sequence 'rx bounce.ray'. RayStorm will now generate your frames. When RayStorm finished the work you must glue the pictures together to get the animation.

That's all. Have fun!

## 1.70 Tips&Tricks

Tips&Tricks

- The commands 'TEXTUREPATH', 'OBJECTPATH' and 'BRUSHPATH' are relative to the directory RayStorm is started from.
- RayStorm renders faster if you don't use planes, because intersections with planes cannot be calculated with the octree (helpfull in scenes with motion blur or soft shadows).
- If RayStorm crashes with scenes with reflections and transparence, try to start RayStorm with a larger stack (e.g. 8192 Bytes).

## 1.71 Textures

TEXTURES

Textures are mathematical generated patterns which can be applied to the surface of a object.

There are several textures in the directory 'textures'.

- Bump
- Checker
- Linear
- Marble
- Radial
- Stars
- Wood

## 1.72 Bump

---

## BUMP

This texture applies bumps to the surface.  
Size of texture determines size of the bumps.

### Parameters:

X bump size - Y bump size - Z bump size  
Sets the 'depth' of the bumps.

### Example:

sphere with radius 1  
IMTEXTURE bump.itx <0,0,0> <0,0,0> <.3,.3,.3> 1 1 1

Picture

## 1.73 Checker

### CHECKER

This texture applies a normal checks pattern to the surface.

Attention!

If you apply a checker texture to a plane, the plane may not be at the same position on which the checker changes its color. Otherwise you get a noisy texture due to rounding errors.

### Parameters:

Color Red - Color Green - Color Blue  
Color of the checks, other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color of the checks.

Filter Red - Filter Green - Filter Blue  
Filter color of the checks.

Example

## 1.74 Linear

### LINEAR

This texture varies the color of the object in the y-direction of the texture.

### Parameters:

Color Red - Color Green - Color Blue  
Color to interpolate to.

Reflect Red - Reflect Green - Reflect Blue  
Reflect to interpolate to.

Filter Red - Filter Green - Filter Blue  
Filter to interpolate to.

Example

## 1.75 Wood

WOOD

This texture applies a wood like texture to the surface.  
Size of texture determines size of wood.

Parameters:

Color Red - Color Green - Color Blue  
Color. Other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color.

Filter Red - Filter Green - Filter Blue  
Filter color.

Octave  
The higher the octave the noisier are the wood rings.

Frequency  
The higher the frequency the smaller the wood rings.

Example:  
cube with size 2  
IMTEXTURE wood.itx <0,0,0> <0,0,0> <1,1,1> 255 255 50 0 0 0 0 0 0 2 4

Picture

## 1.76 Marble

MARBLE

This texture applies a marble like texture to the surface.  
Size of texture determines size of bumps.

Parameters:

Color Red - Color Green - Color Blue  
Color. Other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color.

---

Filter Red - Filter Green - Filter Blue  
Filter color.

Octave  
The higher the octave the noisier is the texture.

Example:  
cube with size 2  
IMTEXTURE marble.itx <0,0,0> <0,0,0> <1,1,1> 150 50 50 0 0 0 0 0 0 7

Picture

## 1.77 Radial

RADIAL

This texture varies the color of the object radial around the texture axis.

Parameters:

Start radius  
Interpolation start radius.

End radius  
Interpolation end radius.

Color Red - Color Green - Color Blue  
Color to interpolate to.

Reflect Red - Reflect Green - Reflect Blue  
Reflect to interpolate to.

Filter Red - Filter Green - Filter Blue  
Filter to interpolate to.

Example

## 1.78 Stars

STARS

This texture applies randomly stars to the surface.

Parameters:

Color Red - Color Green - Color Blue  
Color of the stars.

Density  
Star density. The higher the more stars (0. - 1.).

---

Example

## 1.79 Known Bugs

KNOWN BUGS

- RayStorm crashes with some Imagine textures (DinoSkin,FrogSkin,...) if you use MUI 3.2 (maybe also 3.0 and 3.1). With MUI 2.3 it all works fine. Maybe there'll be a newer version of MUI soon.

## 1.80 Legal Stuff

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## 1.81 Credits

CREDITS

We want to thank the following persons:

---

- Bernhard Moench - chairman of Plasma Pictures (a great Amiga club)

Address:

Plasma Pictures  
Reality and Imagination!

Bernhard Moench  
Regensburger Strasse 28c

10777 Berlin  
GERMANY

- Stephan Dorenkamp & Marcus Ritter - for testing
- Maan Hamze - for testing, hundrets of suggestions and bugreports...  
... and many many E-Mails

## 1.82 Register

REGISTER

If you like RayStorm use the registration programm to register.  
Fill out the registration form and press the Print button.  
If the printer is installed correctly, the registration is printed out.  
You can get information about the current agreements by pressing the Info button.

## 1.83 Author

AUTHORS

For bug reports, comments, suggestions ... you can contact us at the following addresses (E-mail preferred).

Amiga-version:

Andreas Heumann

E-mail: calvin@sol.wohnheim.uni-ulm.de (or heumann@hugo.rz.fh-ulm.de)  
S-mail: Heilmeyersteige 105  
89075 Ulm  
Germany

PC-version:

Mike Hesser

E-mail: calvin@sol.wohnheim.uni-ulm.de  
S-mail: Heilmeyersteige 105  
89075 Ulm

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Germany

## 1.84 History of Changes

### HISTORY

version 1.0 (09-July-95)

- first release.

version 1.01 (15-August-95)

- added soft shadows
- added random jitter
- added brush repeat and mirror

version 1.02 (16-August-95)

- bugfix: altitude mapping -> black object: fixed
- bugfix: loading of TDDD-objects with brushes crashed: fixed
- added backdrop picture
- added BRIGHT-flags for surface
- added fog
- deleted TRANSATTU

version 1.03 (17-August-95)

- bugfix: sphere intersection test: fixed

version 1.04 (21-August-95)

- added global fog

version 1.05 (28-August-95)

- added animation commands

version 1.06 (01-September-95)

- added motion blur

version 1.07 (10-September-95)

- added specular brush mapping

version 1.08 (11-September-95)

- added rendering box

version 1.081 (08-October-95)

- added listview for history
- added global reflection map
- changed error messages

version 1.082 (11-October-95)

- improved memory management for Imagine objects

version 1.083 (12-October-95)

- changed spotlight direction to lookpoint and added actor for lookpoint
- new form for vectors '<x,y,z>'
- new form for colors '[r,g,b]'

version 1.1 (18-October-95)

- next official release
-

version 1.11 (19-October-95)

- bugfix: Imagine fog objects are now loaded properly
- added parameter check for field rendering

version 1.12 (21-October-95)

- speedup of motion blur

version 1.13 (01-November-95)

- now more than one path with PATH-commands possible
- bugfix: spotlight look point changed camera view point
- added soft interpolation of colors for brushmapping
- bugfix: objects behind light sources casted shadows

version 1.14 (03-November-95)

- changed default gaussian filter width from 1.8 to 1.3
- bugfix: problem with global fog
- plane can now be animated
- changed axis position in flat brush mapping
- added 'Time spend' and 'Time left'

version 1.15 (28-November-95)

- added PNG- and ILBM-modules
- added radial texture

version 1.16 (09-January-96)

- bugfix in PNG-module: had problems with palette pictures
- bugfix motion blur: had a problem with voxel calculations
- bugfix motion blur: had no motion blur in scenes with planes
- added TGA-module
- added 'SOFTSHADOW' to 'DISTRIB'
- optimized octree (up to 10% faster)
- added 'FALLOFF' for 'POINTLIGHT' and 'SPOTLIGHT'
- bugfix can now load plane
- bugfix can now load multiple planes or perfect spheres

version 1.17 (18-February-96)

- object loading is now done in modules
- added 3DS module
- bugfix in TDDD-module: hardness is now used to set REFEXP
- brushes and textures are no applied to surfaces which lie between the light source and the illuminated surface
- bugfix antialiasing: there where some bright pixel trash in the picture if antialiasing with fog was used
- rewrote bump, wood and marble textures
- global reflections map is now applied in 'QUICK' mode too

version 1.2 (29-February-96)

- bugfix 'ANTIALIAS' command: parameter CONTRIB produced error 30
- bugfix: last line of picture has been always black
- bugfix: had problems with Imagine 4.0 TDDD objects

version 1.21 (25-March-96)

- TDDD objects are now rotated and scaled relative to axis of first object
  - bugfix: since 1.2 shadows in motion blur scenes were calculated false
  - bugfix: in some cases there were vertical and horizontal stripes in rendered pictures
-

- bugfix: triangles which were exactly in one plane (XY,XZ,YZ) disappeared

version 1.22 (25-April-96)

- bugfix: had problems with sharp edges of TDDD objects
- bugfix: altitude brush mapping produced ugly results
- bugfix: fixed some motion blur bugs
- added 'SURFACE' to 'LOADOBJ' to replace objects surface with own surface
- added Datatype support for all commands which load brushes

## 1.85 PC-version

PC-VERSION

The PC version is available on the Internet.

The most import differences between the PC-Version and the Amiga-Version are:

- the Amiga-Version is able to load Imagine texture-files
- the PC-Version uses its own script language, whereas the Amiga-Version uses ARExx

## 1.86 Homepage

HOMEPAGE

Come and visit our RayStorm-Homepage! There you can always get the latest version of RayStorm and can see some example pictures.

The address:

<http://sol.wohnheim.uni-ulm.de/~calvin/raystorm.html>

## 1.87 Future

FUTURE ADDITIONS

- modeler
  - more objects (torus, cylinder, ...)
  - JPEG-saver
  - use Imagine staging files
  - animation language (ALAN)
  - shadow caching
  - more textures
  - don't allocate whole picture buffer at once
  - diffuse reflectivity
  - diffuse transparency
  - better light FX (lens flares)
  - log file
  - apply post-2D-FX
  - spline interpolation for actors
-

- load Lightwave format
  - CSG (Constructive Solid Geometry)
  - metaballs
  - some extra programs (e.g. terrain and plant generation)
-