UCD Scene Graph File Format Specification

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1 Introduction

2 Basic Types

2.1 Range

(range min max)
describes an interval of the reals: \((min, max)\).

2.2 Vector

(vector x y z)  
describes a 3-vector with components \(x\), \(y\) and \(z\).

2.3 Point

(point x y z)  
describes a point with coordinates \(x\), \(y\), and \(z\).

2.4 Normal

(normal x y z)  
describes a normal with \(x\), \(y\), and \(z\) components.
2.5 Texture Coordinates

(tcoord s t u v)

describes a texture coordinate. Unspecified coordinates default to 0.

2.6 Color

(spectral (range min max) bin1bin2...bin_n) describes a spectral color with n bins uniformly distributed in (min, max)

(spectral (λ_1 bin_1) ... (λ_n bin_n)) describes a spectral color with n bins (bin_i is the amplitude of the ith frequency).

3 Names

(define name exp)

Associates identifier name with expression exp. In expressions following the define, name may be used in place of the expression for exp. Whether referencing an object by name multiple times creates multiple instances in the scene is implementation dependent.

Example:

(define mybox (box (point 0 0 0) (point 1 1 1)))

creates a unit box which may subsequently be referenced as follows:

(scale 1 2 1 mybox)

4 Attributes

(attrib obj attr)

Sets attribute attr in object obj.

5 Camera

(camera attribute_1 ... attribute_n) camera is a global level object and does not need to be referenced later. describes a camera with the following attributes, which may be given in any order. [what should default values be?]
5.1 Lenses

5.1.1 Pinhole

(lens pinhole)
sets a basic pinhole lens. This is the default value of lens if the lens parameter is not specified.

5.1.2 Thin

(lens thin-lens fstop fov)
sets a thin lens for the camera. Aperture diameter is $50mm/f_{\text{stop}}$.

5.2 Orientation

5.2.1 Up

(up vector)
indicates an up vector (section 2.2) for the camera. Default is (0,1,0).

5.2.2 At

(at point)
indicates the focal point of the camera in local coordinates. Default is (0,0,1).

5.2.3 Eye

(eye point)
indicates the location of the camera in local coordinates. Default is (0,0,0).

5.3 Shutter speed

(shutter (range begin end))
indicates when the camera’s shutter is open. Default is (0,0) - meaning that the scene is not time dependent.
6 Geometric Primitives

6.1 Point

\( \text{point-obj } x \ y \ z \)  
  describes a point with coordinates \( x, y, \) and \( z \). This is useful for specifying point lights.

6.2 Sphere

\( \text{sphere } \text{center } \text{radius } \text{material} \)  
  describes a sphere with point (section 2.3) \( \text{center} \) and radius \( \text{radius} \). \( \text{material} \) is the material associated with this sphere.

6.3 Box

\( \text{box } \text{min } \text{max } \text{material} \)  
  describes an axis aligned box with minimum coordinate \( \text{min} \) and maximum coordinate \( \text{max} \). \( \text{min} \) and \( \text{max} \) are points (section 2.3). \( \text{material} \) is the material associated with this box.

6.4 Triangle

\( \text{triangle } \text{point}_0 \text{ point}_1 \text{ point}_2 \text{ normal}_0 \text{ normal}_1 \text{ normal}_2 \text{ tcoord}_0 \text{ tcoord}_1 \text{ tcoord}_2 \text{ material} \)  
  describes a triangle with points (section 2.3) \( \text{point}_0, \text{point}_1, \text{and } \text{point}_2 \), normals (section 2.4) \( \text{normal}_0, \text{normal}_1, \text{and } \text{normal}_2 \), and texture coordinates (section 2.5) \( \text{tcoord}_0, \text{tcoord}_1, \text{and } \text{tcoord}_2 \). Normals and texture coordinates are optional. \( \text{material} \) is the material associated with this triangle.

6.5 Quad

\( \text{quad } \text{point}_0 \text{ point}_1 \text{ point}_2 \text{ point}_3 \text{ normal}_0 \text{ normal}_1 \text{ normal}_2 \text{ normal}_3 \text{ tcoord}_0 \text{ tcoord}_1 \text{ tcoord}_2 \text{ tcoord}_3 \text{ material} \)  
  describes a quadrilateral with points (section 2.3) \( \text{point}_0, \text{point}_1, \text{point}_2, \) and \( \text{point}_3 \), normals (section 2.4) \( \text{normal}_0, \text{normal}_1, \text{normal}_2, \text{and } \text{normal}_3 \), and texture coordinates (section 2.5) \( \text{tcoord}_0, \text{tcoord}_1, \text{tcoord}_2, \text{and } \text{tcoord}_3 \).
Normals and texture coordinates are optional. \textit{material} is the material associated with this quad.

\textbf{6.6 Cylinder}

\texttt{cylinder end\textsubscript{0} end\textsubscript{1} radius material}

\textit{describes} a cylinder with major axis vector \textit{end\textsubscript{1} – end\textsubscript{0}}. \textit{radius} is the radius perpendicular to the axis vector. \textit{material} is the material associated with this cylinder.

\textbf{7 Collections}

\texttt{collect type p\textsubscript{0}…p\textsubscript{n} material}

\textit{type} is the type of collection specified. The only one that must be supported is “group”. You can add your own types. All told this could include:

- group
- bvh
- ugrid
- hgrid
- octree
- bsptree
- kdtree
- etc...

The collection is a collection of all the objects specified \textit{p\textsubscript{0}…p\textsubscript{n}}. If \textit{material} is specified, it overrides the materials given in all of the collected objects \textit{p\textsubscript{0} through p\textsubscript{n}}.
8 Transforms

8.1 Translate

\( \text{translate } v \ obj \)

describes a translation of object \( obj \) by vector \( v \).

8.2 Rotate

\( \text{rotate } v \ \theta \ obj \)

describes a rotation of object \( obj \) of \( \theta \) radians about axis \( v \).

8.3 Scale

\( \text{scale } s_x \ s_y \ s_z \ obj \)

scales each dimension of \( obj \) according to \( s_x, s_y, s_z \).

9 BSDFs

\( \text{bsdf } type \)

describes a Bidirectional Scattering Distribution Functions (BSDFs). Type is one of the following identifiers:

“lambertian” specifies a lambertian (perfectly diffuse) BSDF

“specular” specifies a specular reflector (think chrome).

“dialectric” specifies a specular refractor (think glass).

10 Materials

\( \text{material } bsdf \ \text{color} \)

describes a material with a bsdf \( bsdf \) and spectrum (section 2.6) \( color \).
11 Light

(light type geometry reflection emission)
   describes a light with type type, shape given by geometry reflectivity
   reflection, and emissivity emission.
   Valid types are:
   • uniform

12 Example Files

12.1 The Cornell Box

;;;Cornell box copied to ucd format by Brian Budge 4/16/04
;;;

#|
This is a block comment
|#

(camera
   (lens thin-lens 22 0.6747409422) ;Format here is lens lens_type fstop fov
   ;aperture diameter = 50mm / fstop
   (eye (point 278 273 -800))
   (up (vector 0 1 0))
   (at (point 0 0 350)) ;note that the "at" point determines focal distance
   (time (range 0 0)) ;start and end shutter open times - no need to worry about it
)

(define white
   (spectral (range 400 700)
      0.343 0.445 0.551 0.624 0.665 0.687 0.708 0.723
      0.715 0.710 0.745 0.758 0.739 0.767 0.777 0.765
      0.751 0.745 0.748 0.729 0.745 0.757 0.753 0.750
      0.746 0.747 0.735 0.732 0.739 0.734 0.725 0.721
      0.733 0.725 0.732 0.743 0.744 0.748 0.728 0.716
   )
)
(define red
  (spectral (range 400 700)
    0.040 0.046 0.048 0.053 0.049 0.050 0.053 0.055
    0.057 0.056 0.059 0.057 0.061 0.061 0.060 0.062
    0.062 0.062 0.061 0.062 0.060 0.059 0.057 0.058
    0.058 0.058 0.056 0.055 0.056 0.059 0.057 0.055
    0.059 0.059 0.058 0.059 0.061 0.061 0.063 0.063
    0.067 0.068 0.072 0.080 0.090 0.099 0.124 0.154
    0.192 0.255 0.287 0.349 0.402 0.443 0.487 0.513
    0.558 0.584 0.620 0.606 0.609 0.651 0.612 0.610
    0.650 0.638 0.627 0.620 0.630 0.628 0.642 0.639
    0.657 0.639 0.635 0.642)
)

(define green
  (spectral (range 400 700)
    0.092 0.096 0.098 0.097 0.098 0.095 0.095 0.097
    0.095 0.094 0.097 0.098 0.096 0.101 0.103 0.104
    0.107 0.109 0.112 0.115 0.125 0.140 0.160 0.187
    0.229 0.285 0.343 0.390 0.435 0.464 0.472 0.476
    0.481 0.462 0.447 0.441 0.426 0.406 0.373 0.347
    0.337 0.314 0.285 0.277 0.266 0.250 0.230 0.207
    0.186 0.171 0.160 0.148 0.141 0.136 0.130 0.126
    0.123 0.121 0.122 0.119 0.114 0.115 0.117 0.117
    0.118 0.120 0.122 0.128 0.132 0.139 0.144 0.146
    0.150 0.152 0.157 0.159)
)

(define lightreflect
  (spectral (range 400 700) 0.78 0.78 0.78 0.78)
)
(define lightemission
  (spectral (range 400 700) 0.0 8.0 15.6 18.4) ; yeah, the light is slightly yellow)
)

(define ourlight
  (light uniform (quad (point 343 548.7 227) (point 343 548.7 332) (point 213 548.7 332) (point 213 548.7 227) (reflect lightreflect) (emit lightemission))
    )
)

(define whitelamb (material (brdf lambertian) white))
(define redlamb (material (brdf lambertian) red))
(define greenlamb (material (brdf lambertian) green))

(define floor
  (quad (point 556 0 0) (point 0 0 0) (point 0 0 559.2) (point 556 0 559.2)) whitelamb
)

(define ceiling
  (quad (point 556 548.8 0) (point 556 548.8 559.2) (point 0 548.8 559.2) (point 0 548.8 0)) whitelamb
)

(define backwall
  (quad (point 556 0 559.2) (point 0 0 559.2) (point 0 548.8 559.2) (point 556 548.8 559.2)) whitelamb
)

(define greenwall
  (quad (point 0 0 559.2) (point 0 0 0) (point 0 548.8 0) (point 0 548.8 559.2)) greenlamb
)

(define redwall
  (quad (point 556 0 0) (point 556 0 559.2) (point 556 548.8 559.2) (point 556 548.8 0)) redlamb
)
; short block
(define shortblock
  (collect group
    (quad (point 130 165 65) (point 82 165 225) (point 240 165 272) (point 290 114))
    (quad (point 290 0 114) (point 290 165 114) (point 240 165 272) (point 240 0 272))
    (quad (point 130 0 65) (point 130 165 65) (point 290 165 114) (point 290 0 114))
    (quad (point 82 0 225) (point 82 165 225) (point 130 165 65) (point 130 0 65))
    (quad (point 240 0 272) (point 240 165 272) (point 82 165 225) (point 82 0 225))
    (whitelamb)
  )
)

; tall block
(define tallblock
  (collect group
    (quad (point 423 330 247) (point 265 330 296) (point 314 330 456) (point 472 330 406))
    (quad (point 423 0 247) (point 423 330 247) (point 472 330 406) (point 472 0 406))
    (quad (point 472 0 406) (point 472 330 406) (point 314 330 456) (point 314 0 456))
    (quad (point 314 0 456) (point 314 330 456) (point 265 330 296) (point 265 0 296))
    (quad (point 265 0 296) (point 265 330 296) (point 423 330 247) (point 423 0 247))
    (whitelamb)
  )
)

(collect bvh ; could also be kdtree, ugrid, group, etc...
  ourlight backwall floor ceiling shortblock tallblock redwall greenwall)