# Introductory element — Main element — Part n: Projective Texture Mapping

## 1. Introduction

### 1.1 Name

The name of this component is "Projective Texture Mapping". This name shall be used when referring to this component in the COMPONENT statement (see 7.2.5.4 Component statement).

### 1.2 Overview

This clause describes the projective texture mapping component of this part of ISO/IEC 19775. This includes how projective texture maps are specified and how they are positioned on the 3D scene. Table 1 provides links to the major topics in this clause

Table 1 – Topics

| |
|---|
| 1.Introduction |
|     1.1 name |
|     1.2 Overview |
| 2. Concepts |
|     2.1 Overview |
|     2.2 Projective texturing mapping concepts |
|     2.3 Projective texture map image formats |
| 3. Normative references. |
| 4. Abstract types |
|     4.1 X3DTextureProjectorNode |
| 5. Node References |
|     5.1 TextureProjectorPerspective |
|     5.2 TextureProjectorParallel |

## 2. Concepts

2.1 Overview

This component provides additional texturing extensions to the basic capabilities defined in X3D. Generally, 2D and 3D texture mapping (see Clauses 18 and 33) has been used to enhance the quality of an image generated with a camera or to speed up the generation of an image with respect to a given scene including several geometric models. However, there are some constraints for mapping region and shape of textures over objects. As an extension of texture mapping, the texture image can be projected onto a 3D scene within the projection volume which is constructed from projection parameters such as a projection point, a projection direction and a projection aspect ratio. Fig. 1 shows an example screen shot by applying a projective texture mapping to a 3D virtual scene. The texture mapping of this type is called **a projective texture mapping**.

This projective texture mapping is essential for enhanced rendering effects in a 3D scene such as rendering of beam projection images, visualization of a terrain surface in GIS applications, and medical visualization

2.2 Projective texturing mapping concepts

The projective texture mapping allows a texture image to be projected onto a 3D virtual scene inside the projection volume visible from a specific position called a projection point. The projection volume is determined by projection parameters depending on two types: parallel and perspective projections. In a parallel projection, the parallel volume will become a parallel volume and in a perspective projection, the projection volume will become the shape of the frustum.

The parallel projection can be distinguished into orthographic and oblique according to the defined projection direction. If all the projection lines are orthogonal to the projection plane, the projection is called orthographic projection. All the projection lines in oblique projection will intersect the projection plane at an oblique angle. In order to describe the types of parallel projection, the projection point and projection direction will be given as a point and a vector, respectively. The projection volume in parallel projection can be defined as a parallelepiped.

A projection point

A projection direction

A texture image

A projection aspect ratio

A projection volume
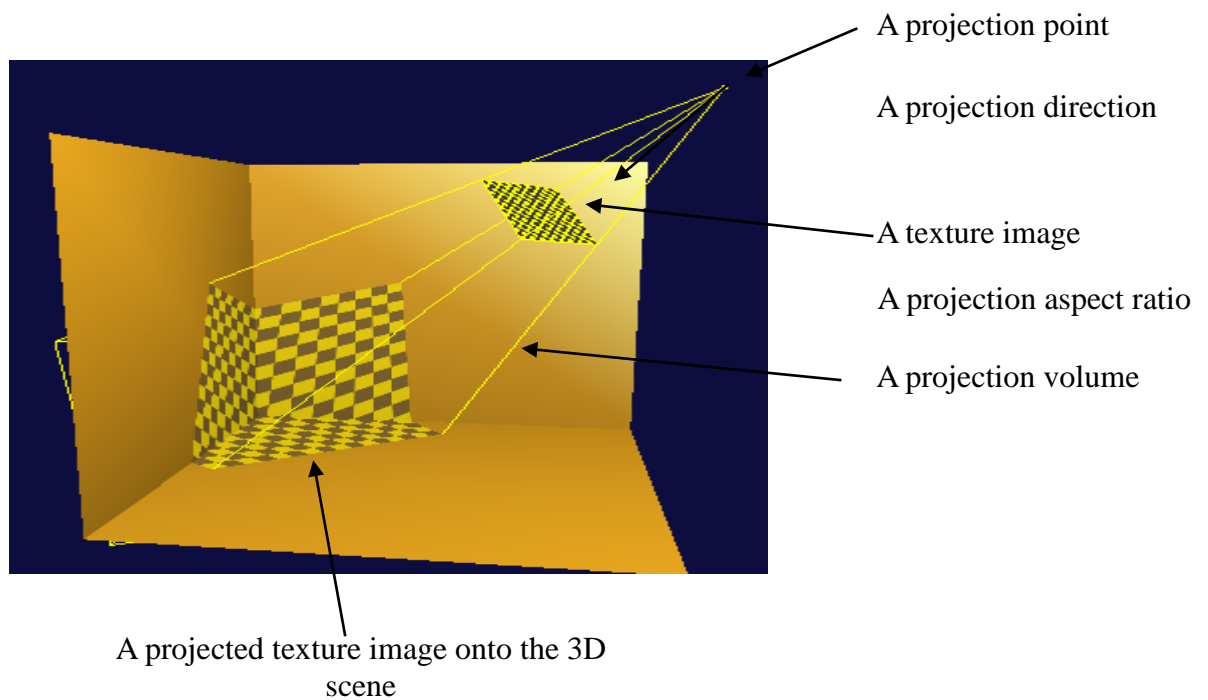
A projected texture image onto the 3D scene

Figure 1 shows a screen shot example by applying projective texture mapping to a 3D scene.

The perspective projection can be defined as a field of view angle from a projection point, an aspect ratio of width and height, near and far planes. In a projective texture mapping, generally, single texture as well as several texture images can be projected onto a scene in a 3D virtual world. Furthermore, multiple projective texture mapping can be performed over a common scene with specific objectives such as photogrammetry or reconstruction of endoscope images. As shown Figure 2, assume that several images are provided, each of which is taken with a different camera. Construction of a terrain surface from those images can be performed by displaying overlapping images obtained after applying several projective textures to the surface model.
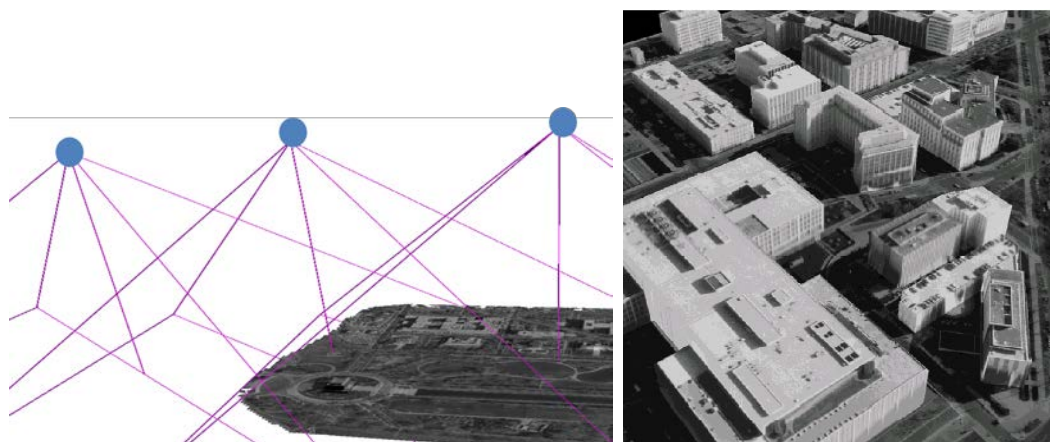


Figure 2. A construction of a terrain surface [2]

Figure 3 describes an example for reconstructing endoscope images over a cylinder by applying projective texture mapping. In a similar manner, each image is captured from an endoscope with perspective view information inside human body.
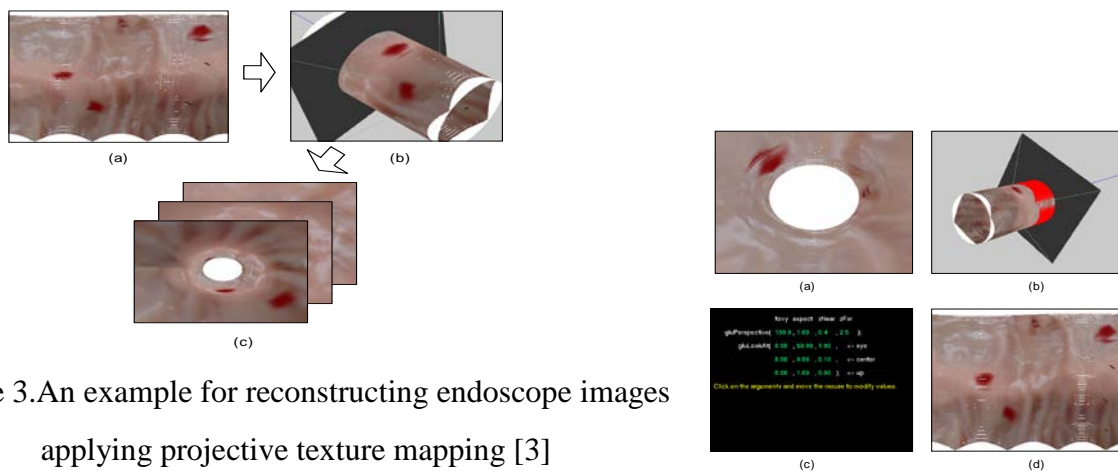


(a)　(b)　(c)

Figure 3.An example for reconstructing endoscope images by applying projective texture mapping [3]



(a)　(b)　(c)　(d)

2.3 Projective texture map image formats

Node types specifying images for projective texture mapping may supply data with a number of color components between one and four. The valid types and interpretations of 3D textures are identical to that for 2D textures. The definition of texture formats is defined in 18.2.1 Texture map formats.

## 3   Normative references

- X3D, ISO standards, [http://www.web3d.org/x3d/](http://www.web3d.org/x3d/).

## 4   Abstract types.

### 4.1   *X3DTextureProjectorNode*

```
X3DTextureProjectorNode : X3DChildNode{
        SFNode          [in,out]        metadata        NULL    [X3DMetadataObject]
        SFString        [in,out]        description     ""
        SFVec3f         [in,out]        location        0 0 1 (-∞,∞)
        SFVec3f         [in,out]        direction       0 0 1 (-∞,∞)
        SFFloat         [out]           aspectRatio
        SFFloat         [in,out]        nearDistance    1
        SFFloat         [in,out]        farDistance     10
        SFBool          [in,out]        global          true
        SFBool          [in,out]        on              true
        SFNode          [in,out]        texture         NULL
                                        [X3DTexture2DNode]
}
```

This abstract node type is the base type for all node types that specify projective texture mapping.

The description field of this node tells the name of the projector, and makes the division of different projectors possible.

The location shows the position of the projector, and this implies projection point.

The direction is the way the projector is heading, and this implies to projection direction.

The aspectRatio is the aspect ratio of the width and length which refers to projection aspect ratio.

The nearDistance and farDistance is the minimum and maximum distance that is shown on the screen, respectively.

We could draw out projection volume and projection texture coordinate from the added fields.

Each projective texture mapping type defines a global field that determines whether the projective texture mapping is global or scoped. Global projective texture mapping performs the texture mappings for all objects that fall within their volume of projective texture mapping influence. Scoped projective texture mapping only performs the texture mappings for objects that are in the same transformation hierarchy as the projective texture mapping; i.e., only the children and descendants of its enclosing parent group are illuminated.

The on field specifies whether the projective texture mapping is performed or not. If on is TRUE, the projective texture mapping is performed for geometry objects in the scene. If on is FALSE, the projective texture mapping is not performed for any geometry in the scene.

See 18 Texturing component for a general description of the X3DTexture2DNode abstract type and interpretation of rendering for 2D images.

# 5 Node reference

## 5.1 TextureProjectorPerspective

```
TextureProjectorPerspective : X3DTextureProjectorNode {
       SFNode   [in,out]       metadata       NULL    [X3DMetadataObject]
       SFString [in,out]       description    ""
       SFVec3f  [in,out]       location       0 0 1
       SFvec3f  [in,out]       direction      0 0 1
       SFFloat  [in,out]       fieldOfView    π/4 (0,π)
       SFFloat  [out]          aspectRatio
       SFVec3f  [in,out]       upVector       0 0 1
       SFFloat  [in,out]       nearDistance   1
       SFFloat  [in,out]       farDistance    10
       SFBool   [in,out]       global         true
       SFBool   [in,out]       on             true
       SFNode   [in,out]       texture        NULL
                               [X3DTexture2DNode]
}
```
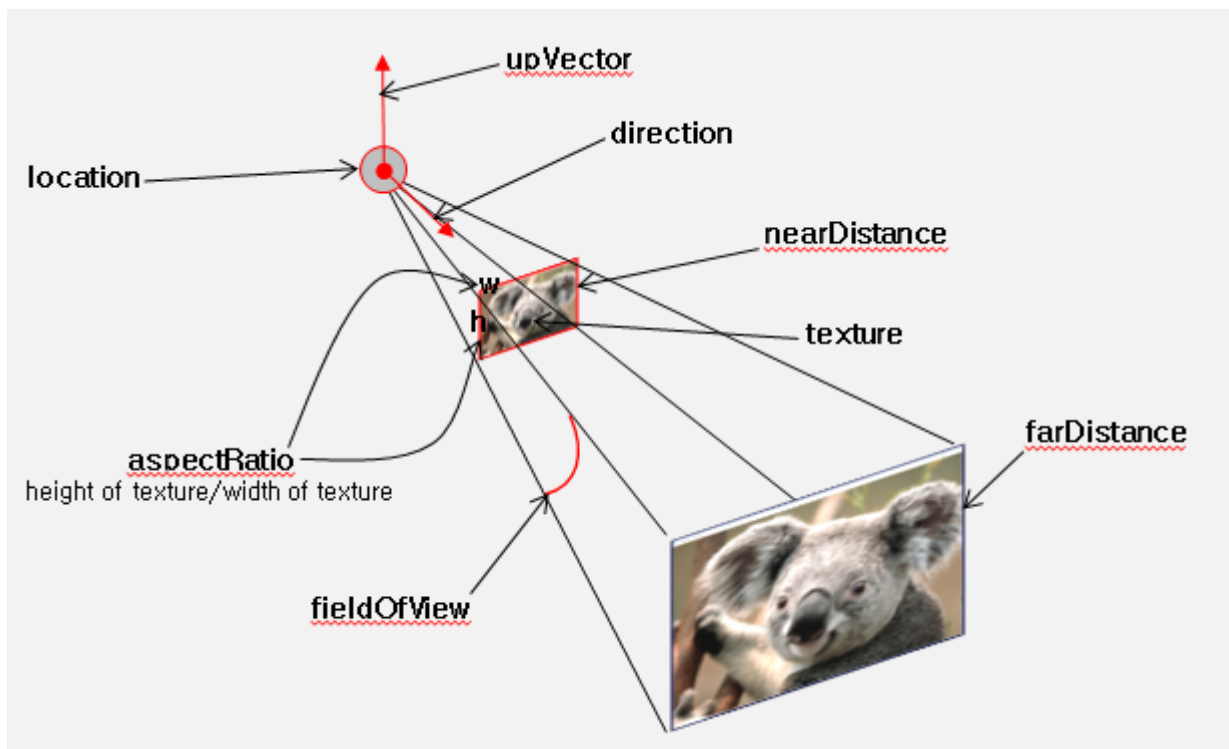
## 5.2 TextureProjectorParallel

```
TextureProjectorParallel : X3DTextureProjectorNode{
        SFNode    [in,out]    metadata        NULL [X3DMetadataObject]
        SFString [in,out]     description     ""
        SFVec3f  [in,out]     location        0 0 1
        SFVec3f  [in,out]     direction       0 0 1
        SFFloat  [out]        aspectRatio
        MFFloat  [in,out]     fieldOfView     -1 -1 1 1 (-∞,∞)
        SFFloat  [in,out]     nearDistance    1
        SFFloat  [in,out]     farDistance     10
        SFBool   [in,out]     global          true
        SFBool   [in,out]     on              true
        SFNode   [in,out]     texture         NULL
                                              [X3DTexture2DNode]
}
```
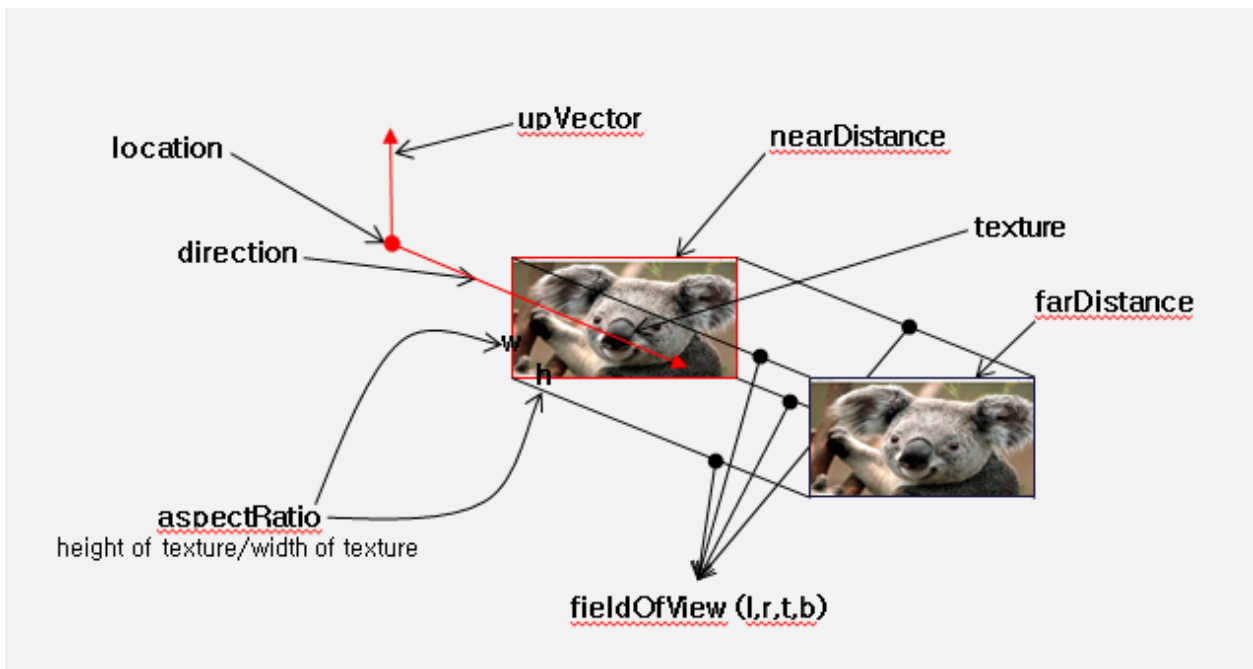


## References

[1] Cass Everitt, Projective Texture mapping, 1999

[2] J.R. Spann and K.S. Kaufman, Photogrammetry using 3D Graphics and Projective Textures, IAPRS, 2000

[3] Eunjung Kim, Kwan-Hee Yoo, Je-Hoon Lee, Yong-Dae Kim, and Younggap You, Composite Endoscope Images from Massive Inner Interestine Photos, Lecture Notes on Artificial Intelligence 4570, pp.1042-1051, 2007 .

[4] http://www.users.globalnet.co.uk/~tomh

# Annex 1: Use cases

## 1 An example of perspective texture mapping

```
<X3D profile="Interactive" version="3.3">
<Scene>
<TextureProjectorPerspective
    description='pt1' location='3 3 3' direction='-1 0 -1'
    fieldOfView= '0.26' nearDistance='1' farDistance='10'
    upVector='0 1 0' global= 'true' on= 'true'>
    <ImageTexture url='apple.jpg' repeatS='false' repeatT='false'/>
</TextureProjectorPerspective>
<Shape>
  <Appearance>
    <Material diffuseColor='0.5 0.5 0.5'/>
  </Appearance>
  <IndexedFaceSet solid='false' coordIndex="3 2 1 0 -1, 4 5 2 3-1, 5 6 1 2 -1">
    <Coordinate point="1 0 1, -1 0 1, -1 0 -1, 1 0 -1, 1 1 -1, -1 1 -1, -1 1 1 "/>
  </IndexedFaceSet>
</Shape>
</Scene>
</X3D>
```

```
<X3D profile="Interactive" version="3.3">

<Scene>

<TextureProjectorPerspective

    description='pt1' location='3 3 3' direction='-1 -1 -1'

    fieldOfView= '0.26' nearDistance='1' farDistance='10'

    upVector='0 1 0' global= 'true' on= 'true'>

    <ImageTexture url='C:/image/apple.jpg' repeatS='false' repeatT='false'/>

</TextureProjectorPerspective>

<Shape>

  <Appearance>

    <Material diffuseColor='0.5 0.5 0.5'/>

  </Appearance>

  <Box/>

</Shape>

</Scene>

</X3D>
```

```
<X3D profile="Interactive" version="3.3">

<Scene>

<TextureProjectorPerspective

    description='pt1' location='3 3 3' direction='-1 -1 -1'

    fieldOfView= '0.26' nearDistance='1' farDistance='10'

    upVector='0 1 0' global= 'true' on= 'true'>

    <ImageTexture url='C:/image/apple.jpg' repeatS='false' repeatT='false'/>

</TextureProjectorPerspective>

<Shape>

  <Appearance>

    <Material diffuseColor='0.5 0.5 0.5'/>

  </Appearance>

  <Cylinder radius='1' height='1.5'/>

</Shape>

</Scene>

</X3D>
```