

Mixed Reality Visualization in X3D - Updates

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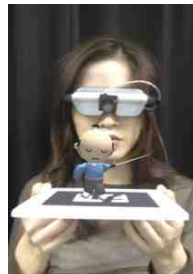
ETRI

Augmented Reality

- What is AR (Augmented Reality) ?
 - "Augmented Reality (AR) is a field of computer research which deals with the combination of real-world and computer-generated data." – wikipedia.org
- Key Features of AR [R. Azuma 97]
 - Combines real and virtual images
 - Interactive in Real-Time
 - Registered in ~~3D~~ Real World



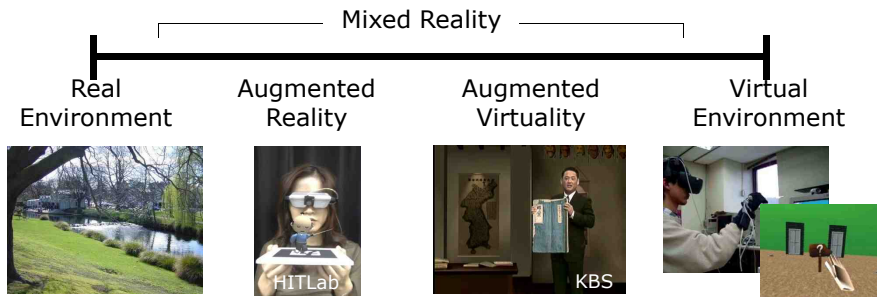
STAR System
[HRL Laboratories, 1998]



ARToolkit
[HITLab, Univ. of Washington, 1999]

Mixed Reality

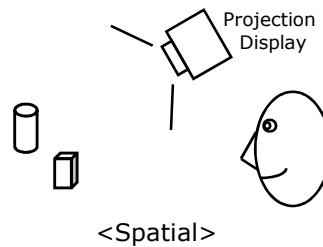
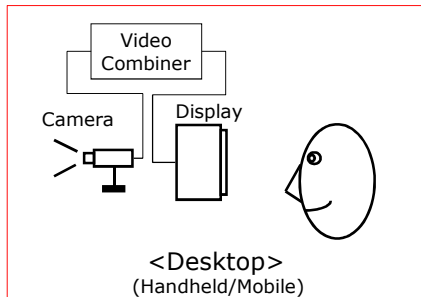
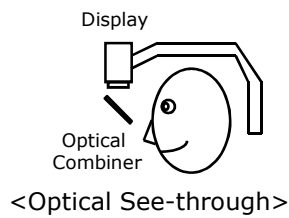
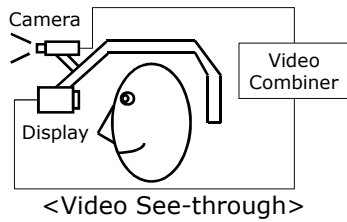
- What is MR (Mixed Reality) ?



[Paul Milgram's Reality-Virtuality Continuum (1994)]

Mixed Reality Display Configurations

[R. Azuma, 1997]



X3DOM AR

- X3DOM
 - HTML5 – WebGL
 - J. Behr, Fraunhofer
- FLARToolkit
 - Requires Flash Plug-in
 - Flash version of AR Toolkit
- Layers X3D scene on top of Flash viewport
- A good platform for experimenting and implementing AR/MR functions as standards
 - Users might benefit more if those functions provided by FLARToolkit becomes a standard in X3D, so that they would not need to handle repetitive wiring between flash and X3D.



Making X3D become MR capable

- Adding real world view
 - Live video (esp. camera on the user's computer)
 - Merging real and virtual image correctly
 - Camera calibration
 - Occlusion
 - Shadow
 - Reflection & Refraction
 - Live movie texture
- Registration
 - Relationship between real and virtual spaces (+ Tracking user's viewpoint)
 - Global and Local coordinates
- Real-time Interactivity
 - Tracking (users & other real world objects)
 - Physics, collision-detection, etc.

AR support @ Fraunhofer

- Jung et al., Web3D 2007
- SFImageSensor:X3DDirectSensorNode {
 - SFImage [in, out] value
 - SFBool [] out FALSE
 - SFString [] label ""}
- Viewpoint:X3DViewpointNode {
 - ...
 - SFVec2f [in, out] principalPoint 0 0
 - SFFloat [in, out] fovAspectRatio 1.0}
- Viewfrustum:X3DViewpointNode {
 - SFMatrix4f [in, out] modelview (identity)
 - SFMatrix4f [in, out] projection (identity)}

Live Video + Calibration & Tracking Info

- LiveCamera Node (proposed by Korean Chapter)
 - A sensor node (child of a scene node)
 - Represents a live video camera (on the user's computer)
 - The 'image' field provides live video image
 - The 'projmat' field provides internal parameters of the camera
 - 'image' and 'projmat' fields provide distortion corrected data
 - The optional 'position' and 'orientation' fields provide camera tracking data

```
LiveCamera {  
  SFImage [out] image  
  SFMatrix4f [out] projmat "1 0 0 0 ... "  
  SFBool [out] on FALSE  
  SFBool [out] tracking FALSE  
  SFVec3f [out] position  
  SFRotation [out] orientation  
}
```

Live Video Support

- Fraunhofer + Korean Chapter

- CameraSensor:X3DDirectSensorNode {
 - SFImage [out] value
 - SFBool [out] on FALSE
 - SFMatrix4f [out] projmat "1 0 0 0 ... "
 - SFBool [out] tracking FALSE
 - SFVec3f [out] position
 - SFRotation [out] orientation

MovieTexture

- An Alternative way to CameraSensor

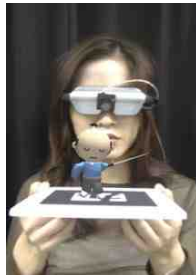
- Making MovieTexture user reconfigurable
- No change in syntax of X3D
- Add a standard behavior of MovieTexture to
 - Ask user if no source is declared
 - A dialog box presented to choose a movie file or a camera hardware

```
...  
<Appearance>  
  <MovieTexture loop='true' url='wrlpool.mpg'/>  
</Appearance>  
...
```

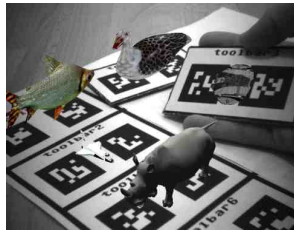
```
...  
<Appearance>  
  <MovieTexture loop='true' url=''/>  
</Appearance>  
...
```

Tracking

- Sensor based Tracking
 - Ultrasonic, Electromagnetic, Mechanical, Optical motion capture
- Computer Vision based Tracking
 - ARToolkit (HITLab), ARTag (Canadian NRC), BazAR (EPFL)



[ARToolkit, HITLab]



[ARTag, CNRC]



[BazAR, EPFL]

Registration & Real-time interactivity (cont'd)

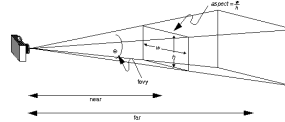
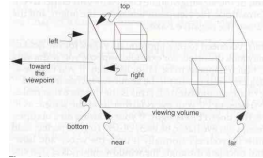
- Tracking methods
 - Too many/various to be standardized...
 - Delegation to browser/viewer implementation
 - Browser decides (or provides an interface to choose) which tracking methods/devices to use
 - Tracking technology in use is hidden, and only the tracking results are provided into X3D scene
 - X3D only provides interfaces to the tracking results
 - X3D authors do not have to worry about the hardware system setup in run-time

```
CameraSensor:X3DDirectSensorNode {
  SFImage      [in, out] value
  SFBool       [] out FALSE
  SFMatrix4f   [out] projmat "1 0 0 0 ..."
  SFBool       [out] tracking FALSE
  SFVec3f      [out] position
  SFRotation   [out] orientation
}
```

Camera Calibration

- Standard Viewpoint Nodes

- OrthoViewpoint
 - Orthographic projection
 - fieldOfView in min-max box
- Viewpoint
 - Perspective projection
 - fieldOfView in radian



- Viewpoint node for MR visualization needs ...

- Directly assigning projection matrices
 - Assigning values from LiveCamera
- Easily support tracking information
 - Position, orientation field
 - Defined in X3DViewpointNode abstract type

AR support @ Fraunhofer

- Jung et al., Web3D 2007
- SFImageSensor:X3DDirectSensorNode {

SFImage	[in, out]	value	
SFBool	[]	out	FALSE
SFString	[]	label	""
- Viewpoint:X3DViewpointNode {

...			
SFVec2f	[in, out]	principalPoint	0 0
SFFloat	[in, out]	fovAspectRatio	1.0
- Viewfrustum:X3DViewpointNode {

SFMatrix4f	[in, out]	modelview	(identity)
SFMatrix4f	[in, out]	projection	(identity)

Camera Calibration

- **MatrixViewpoint** (previously named as a LiveViewpoint)

```
MatrixViewpoint : X3DViewpointNode{
  SFMatrix4f      [in]      projmat
  SFVec3f         [in,out]  position
  SFRotation      [in,out]  orientation
  SFNode          [in,out]  cameraSensor
}
```

```
<Scene>
  <CameraSensor DEF='USBCam1'/>
  <MatrixViewpoint liveCamera='USBCam1'/>
  <Shape> ... </Shape>
</Scene>
```

Or, using routes...

```
<Scene>
  <CameraSensor DEF='USBCam1'/>
  <MatrixViewpoint DEF='MRView'/>
  <Shape> ... </Shape>
  <ROUTE fromNode='USBCam1' fromField='projmat'
        toNode='MRView' toField='projmat'/>
  <ROUTE fromNode='Tracker' fromField='position'
        toNode='MRView' toField='projmat'/>
  <ROUTE fromNode='Tracker' fromField='orientation'
        toNode='MRView' toField='projmat'/>
</Scene>
```

Video on the Background

- Using X3D Layering components applicable, except
 - No guarantee to video image plane being aligned to the viewport
 - Possible problems with incorrect aspect ratio of the movie texture (differ from original live camera image)
 - Future support for depth images might be bothering

Video on the Background

- Current Background Node

```
<Scene>
  <Background groundAngle='1.309 1.571'
    groundColor='0.1 0.1 0 0.4 0.25 0.2 0.6 0.6 0.6'
    skyAngle='1.309 1.571'
    skyColor='0 0.2 0.7 0 0.5 1 1 1 1'
    backUrl='mountns.png'
    frontUrl='mountns.png'
    leftUrl='mountns.png'
    rightUrl='mountns.png' />
</Scene>
```

- Extending the Background Node

```
...
<Live Camera DEF='cam' />
<Background DEF='bg' image='' />
<ROUTE fromNode='cam' fromField='image' toNode='bg' toField='image' />
...
```

- Or Adding a New Node

```
...
<LiveCamera DEF='USBCam1' />
<MovieBackground liveSource='USBCam1' />
...
```

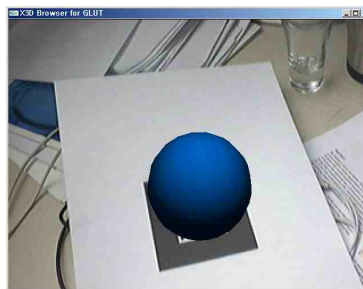
All together

```
...
<Scene>
  <CameraSensor DEF='cam' />

  <Background DEF='bg' />
  <ROUTE fromNode='cam' fromField='image' toNode='bg' toField='image' />

  <MatrixViewpoint cameraSensor='cam' />

  <Transform translation="0 0 40">
    <Shape>
      <Appearance>
        <Material diffuseColor='0 0.5 1' />
      </Appearance>
      <Sphere radius="40" />
    </Shape>
  </Transform>
</Scene>
...
```



MR into X3D - Summary

- CameraSensor
 - Video stream source from a live camera
 - + Camera internal param calibration info source
 - + Camera tracking info source
- Matching Viewpoint to real camera
 - Projection matrix with live camera internal param
 - Position and Rotation with live camera tracking info
- Video Background
 - Render video stream (live or recorded) as a backdrop
- MovieTexture
 - Chroma Keying (for Augmented Virtuality)
 - Using it as a live camera stream source
- Ghost group
 - Depth mask for real objects

Thank you!

Q & A