Korea Chapter Meeting @ SIGGRAPH2011

Supporting Mixed Reality Visualization in X3D

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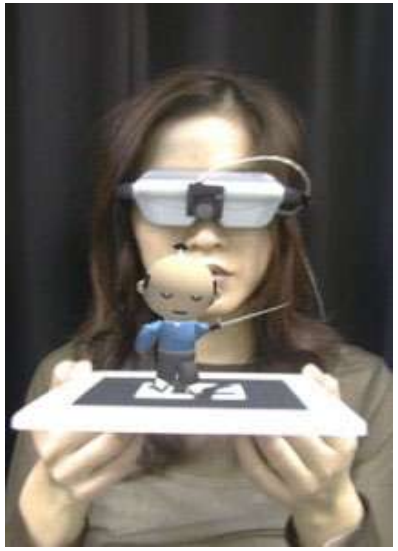
Augmented Reality

- 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

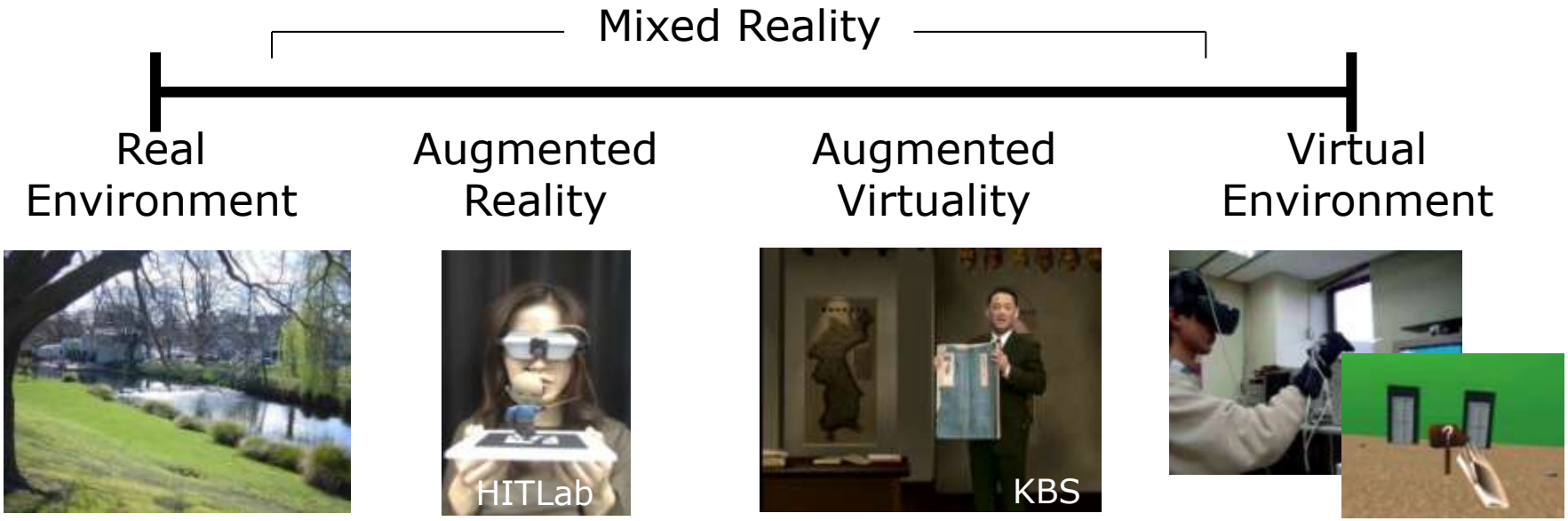
STAR System
[HRL Laboratories, 1998]



ARToolkit
[HITLab, Univ. of Washington, 1999]

Mixed Reality

- What is MR (Mixed Reality) ?



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

AR/MR Applications on the Web

AR Encyclopedia
[metaio.com]

Volvo Ocean Race
Promotion, 2008

Smart Grid Promotion
GE, 2009

BMW Z4 Testrive Promotion,
2009

3D Experience Cerial Box,
2009 [Dassault Systemes]

Ray-Ban virtual mirror promotion,
2009 [FittingBox]

AR Application with X3DOM

- X3DOM
  - HTML5 – WebGL
  - J. Behr, Fraunhofer IGD
- 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.

Requirements of X3D to be AR/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
  - Static - Relationship between real and virtual spaces
  - Dynamic - Tracking user's viewpoint
- Real-time Interactivity
  - Tracking (users & other real world objects)

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	

}

Video on the Background

- Current Background Nodes
  - Describes 3D background that changes according to the viewpoint navigation
  - For AR applications, we need to make video on the background independent from the viewpoint navigation
- ImageBackground Node

```
…
<CameraSensor DEF=‘cam’/>
<ImageBackground DEF=‘bg’ image=‘’/>
 <ROUTE fromNode=‘cam' fromField=‘image‘
            toNode=‘bg' toField=‘image'/>
…
```

MovieTexture / MovieBackground
– An Alternative way to CameraSensor

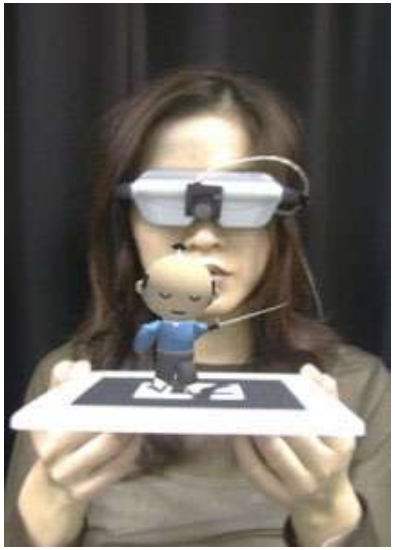
- Making MovieTexture user reconfigurable
- No big change to current X3D spec, no routing
- Add a standard behavior of MovieTexture to
  - Ask user to choose the video source (file or camera) if url field is empty (or specific token is used)

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

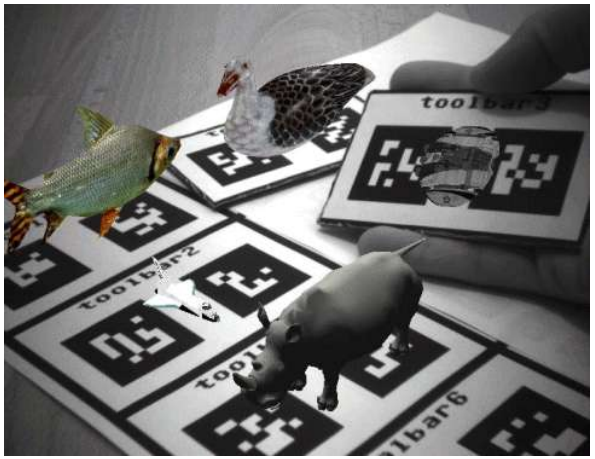
```
...
<MovieBackground url='' />
...
```

Tracking

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



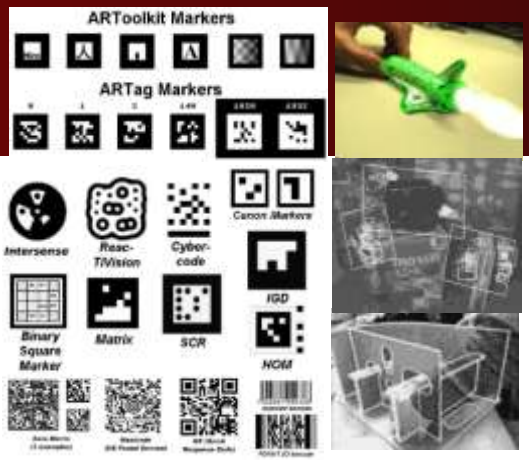
[ARToolkit, HITLab]



[ARTag, CNRC]

[BazAR, EPFL]

Tracking (cont'd)

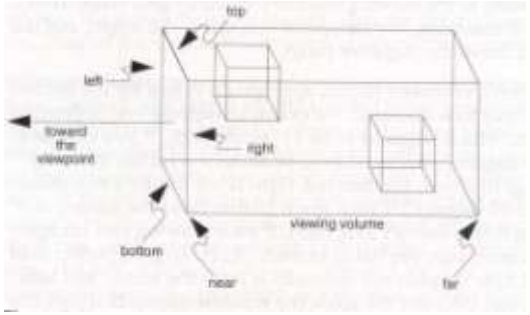


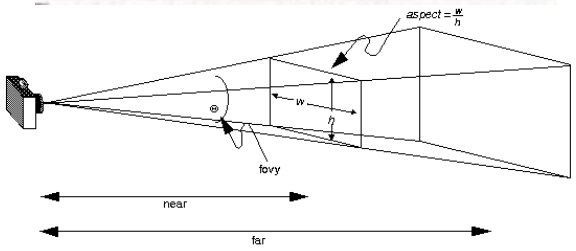
- Tracking methods
  - Too many/various to be standardized...
  - Leave to browser implementation,
    X3D only provides interfaces to the tracking results
    - Browser decides (or provides an interface to choose) which tracking methods/devices to use/support
    - Tracking technology in use is hidden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

```
TrackingSensor:X3DDirectSensorNode {
  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

Camera Calibration

- MatrixViewpoint

```
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>
```

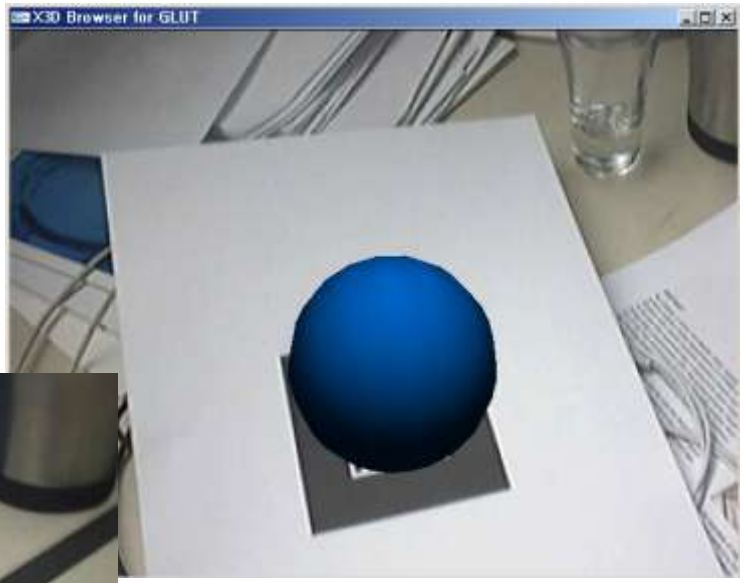
All together – X3D might look like ...

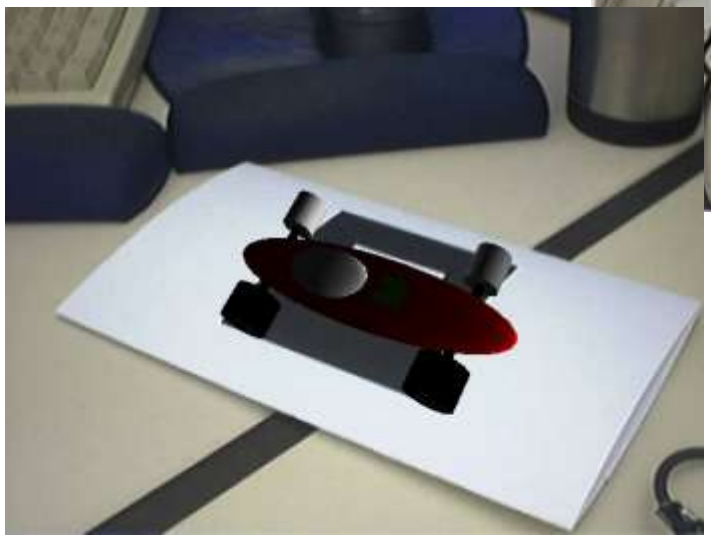
```
...
<Scene>
    <CameraSensor DEF=‘cam’/>

    <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>
...
```



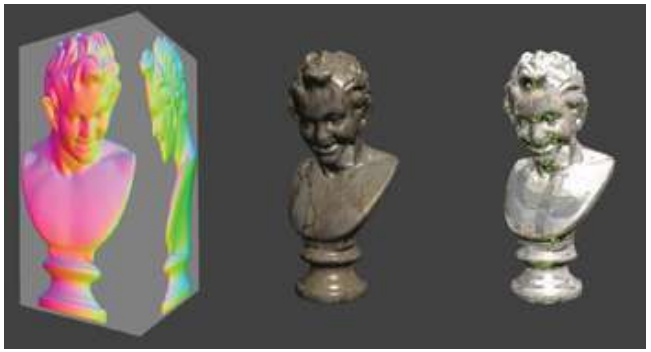


Looking forward to…

- Correct occlusions and Augmented Virtuality
  - Masking - Ghost object rendering
  - Depth image (e.g. stereo image matching, depth camera)
    - Pixel = rgbd
    - Got popular with MS Kinect
    - Support Depth image in X3D nodes (SFImage, MovieBackground, MovieTexture)
  - Heuristics (chroma keying with skin color)
    - Add KeyColor field to MovieTexture

Depth Image
[Wikipedia]

Masking [ETRI]



Relief Texture
[NVIDIA Cg Tutorial]

Chroma Keying / Augmented Virtuality
[Kudlian Software]

Looking forward to…

- OpenSceneGraph (www.openscenegraph.org)
  - C++ based scene graph library
  - Large user community
  - Open source, commercial friendly license
- osgART
  - AR plug-in to OSG
  - Different tracking technologies as plug-ins

- X3D support is missing !?

AR WG

- Started up and running since June 2011
- Active Members:
  - Gun Lee (HIT Lab NZ)
  - Gerard J. Kim (Korea Univ.)
  - Yvonne Jung, Sabine Webel, Johannes Behr (Fraunhofer IGD)
  - Oliver Neubauer (Bitmanagement)

- Slow, but steady
- Looking forward to gain more speed with more participants

- Current tasks
  - Requirement and use cases
  - Comparing and merging proposals

Lots of things to do @ AR WG

Please join us!
You are more than welcome!

Thank you!

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