

HMD based VR Service Framework

July 31 2017

Web3D Consortium

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What is Virtual Reality?

Making an electronic world seem real and interactive

- Not static 3D image
- Not movies
- Moving within the 3D world
- Manipulating objects in the 3D world



Type of VR Experiences

➤ Immersive Spaces

- 360° Panorama image/Video
- High visual quality
- Limited interactivity
 - Changing viewpoint orientation
- User can turn head to see different views
- Fixed Position



➤ Immersive Experiences

- 3D graphics
- Lower visual quality
- High interactivity
- Movement in space
- Interact with virtual objects



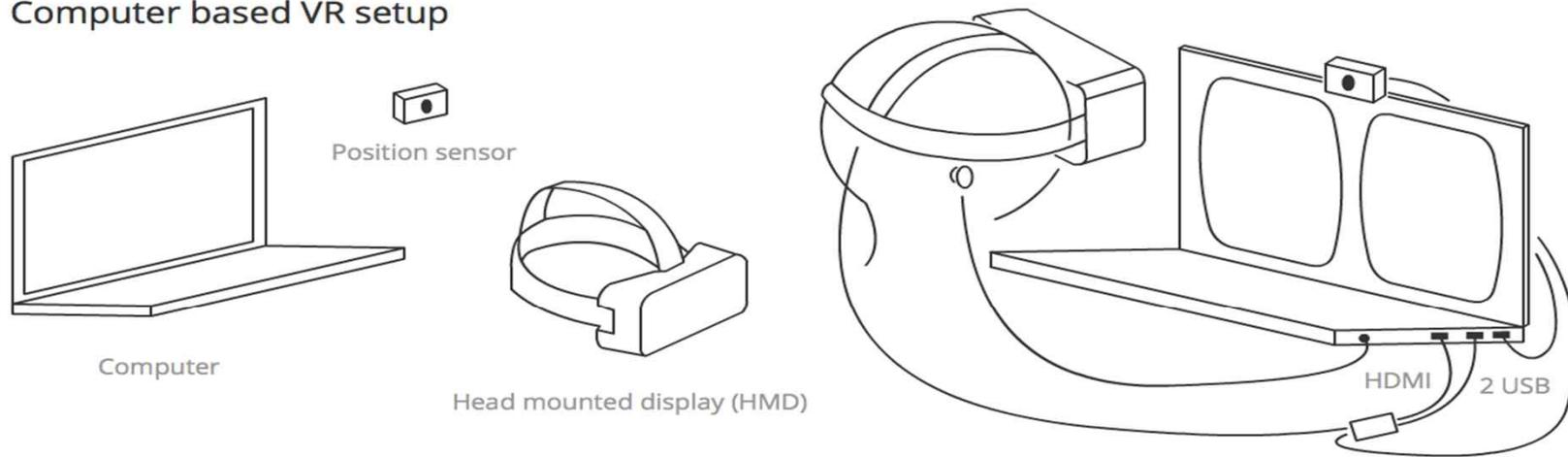
Where 360° VR Walking Tour can apply?

- Virtual Map (University Campus, Hospital, Company, Factory...)
- Visiting Place (Park, Resort, Mountain, Temple...)
- Business Place (Hotel, Restaurant, bars,...)
- More effective than Streetview
 - Add more information
 - Custom
 - Own system
 - Own website

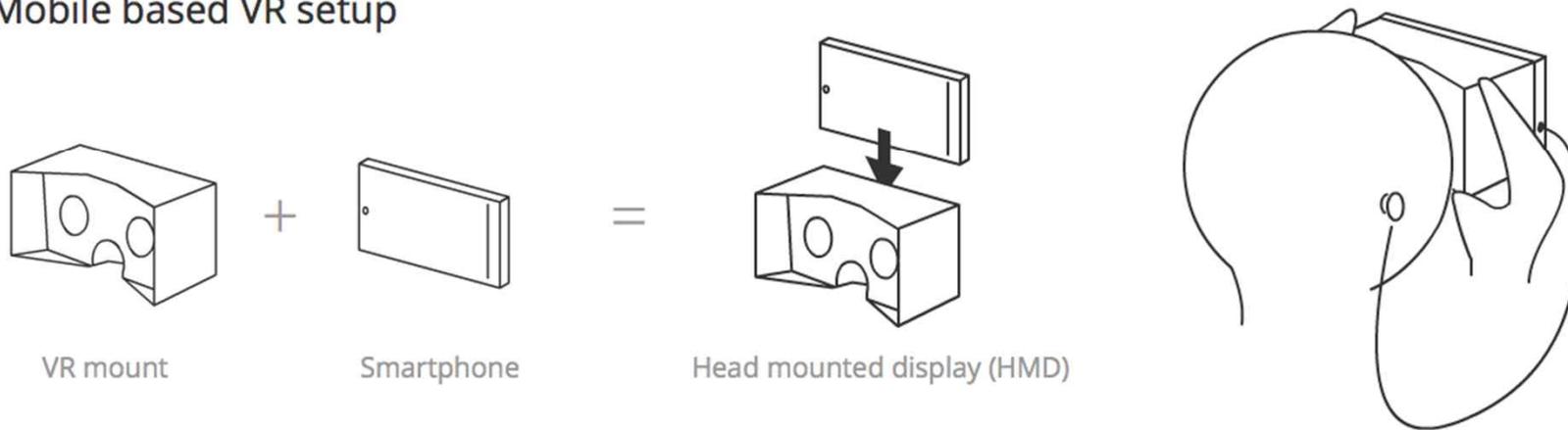


Computer based Vs. Mobile VR

Computer based VR setup



Mobile based VR setup



VR hardware explosion

- Increasing of Virtual reality hardware
- Affordable stereoscopic displays
- Head Mounted Display
- Motion tracking
- Head tracking



VR input devices



VR HMD devices



PC HMDs

- PC HMDs refer to Desktop peripheral acts as external monitor
- Provide deepest, most immersive VR
- Position and orientation tracking
- Tethered – one or more cables connect to computer such as camera for position tracking



Oculus Rift



HTC VIVE



Mobile HMDs

- Custom Android build/ Oculus mobile SDK
- Orientation tracking only
- Support for S6 coming – Samsung Gear VR
- Support for LG G5 – LG VR
- 110 diagonal FOV – Gear VR
- 1000hz refresh rate – Gear VR



Samsung Gear
VR



LG VR



Drop-in phone viewers

- Open specification for mobile VR
- Orientation tracking only
- Standard Android, iOS support, using simple stereo rendering and accelerometer tracking
- Just add SmartPhone
- 90 degree FOV – Cardboard
- 200hz refresh rate



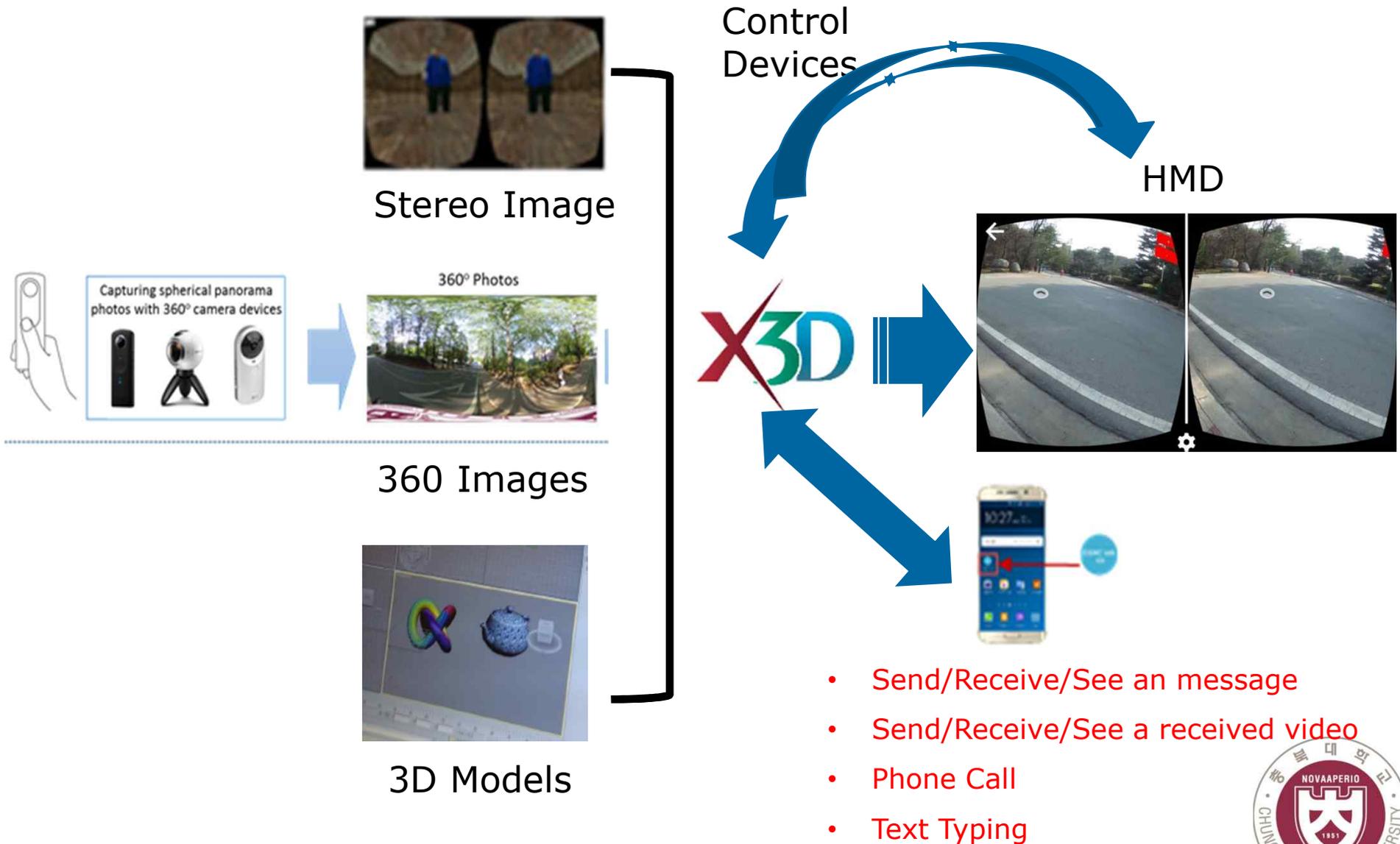
Google
Cardboard



VR BOX

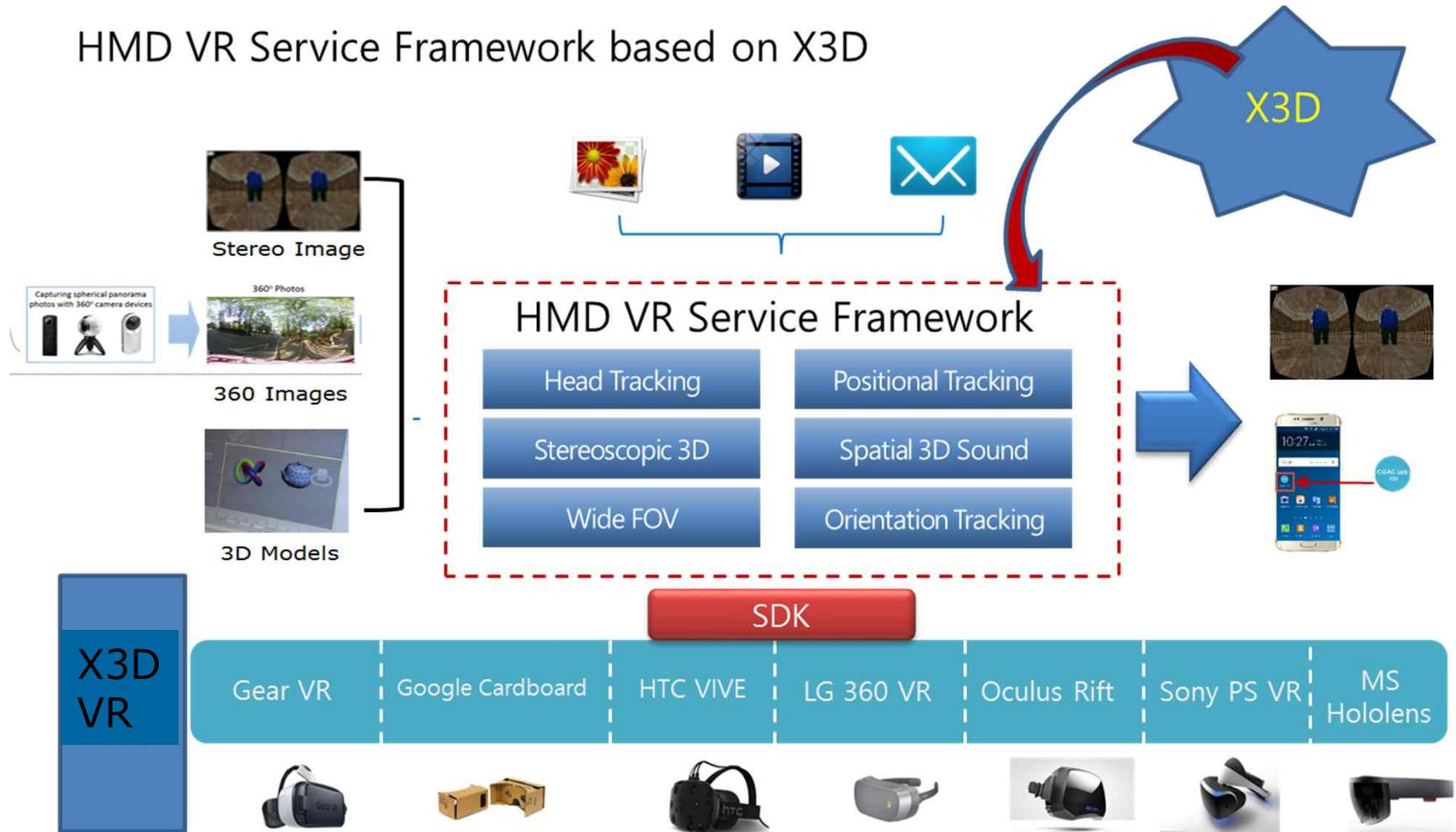


HMD VR service using X3D



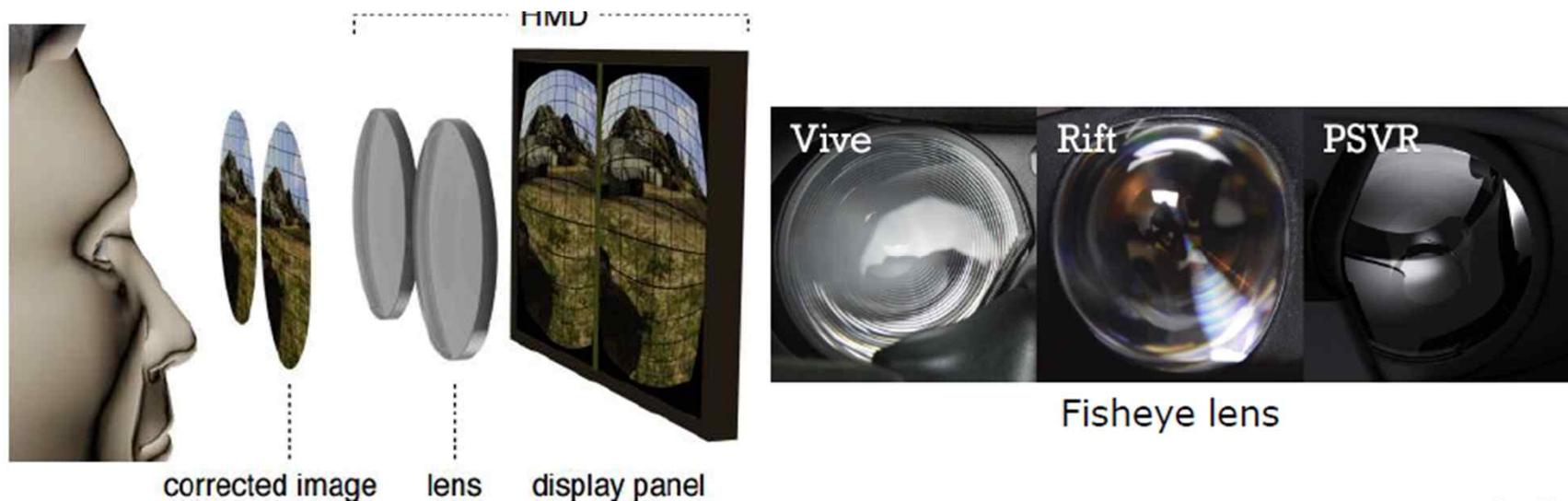
X3D VR walking tour

HMD VR Service Framework based on X3D



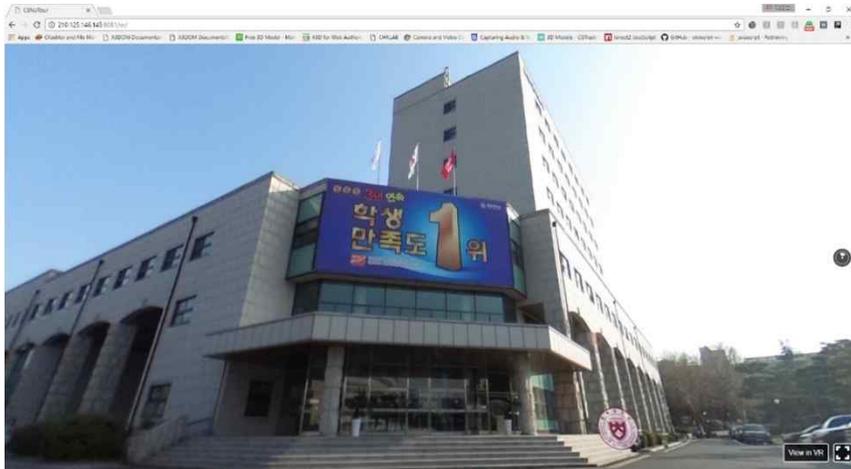
HMD VR service Issues using X3D

- Interaction of X3D content and HMD devices
- Fisheye lens
- Display 4K (2,024 x 2,200) pixels
- A 90Hz refresh rate and 100 nits brightness
- Latency
- Bandwidth
- Seamless message services through smartphones



Interaction of X3D Content and HDM devices

Image generating : One of the most time consuming task in Virtual Reality is generation of 360° images, 3D Objects and 3D world.



Stereo Vision: Accomplished by creating two different images of the world once for each eye.



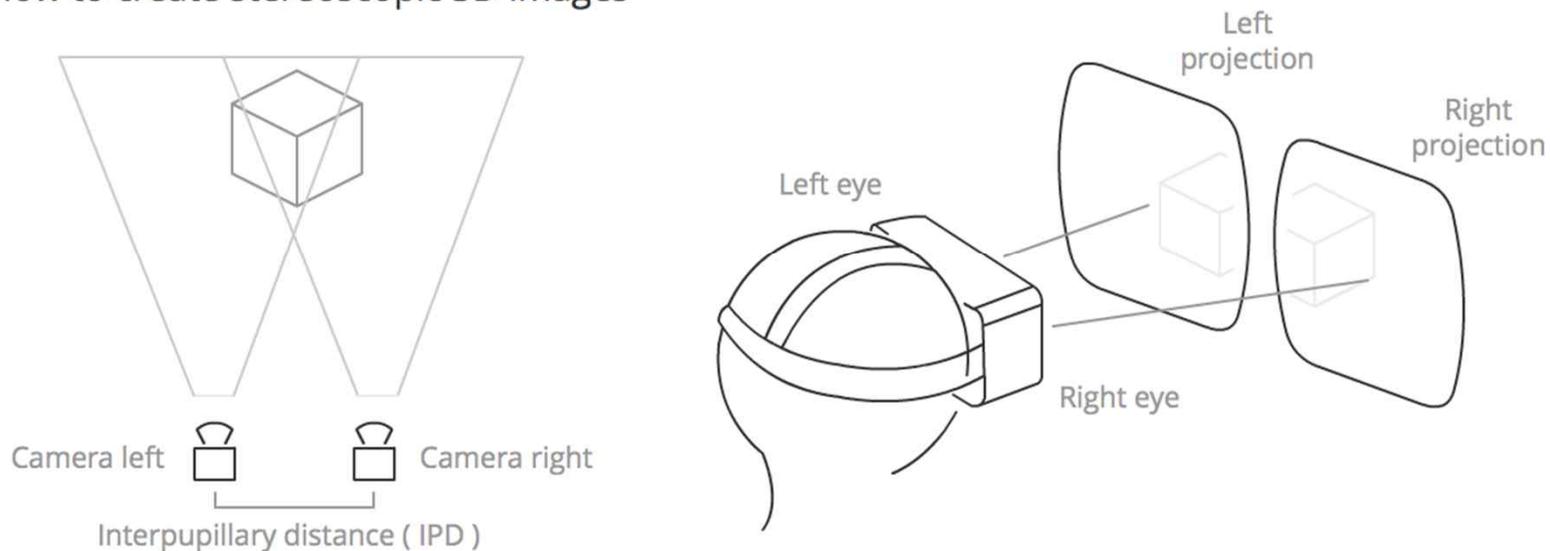
Manipulation & Control Devices : One key element for interaction to the virtual world that is tracking the position of real world objects such as head tracking, side-by-side stereo rendering, spatial audio rendering, detecting user inputs such as the trigger.



Stereoscopic Vision

Stereoscopic vision is the normal vision humans and (most) animals have — the perception of two slightly differing images (one from each eye) as a single image. This results in depth perception, helping us to see the world in glorious 3D.

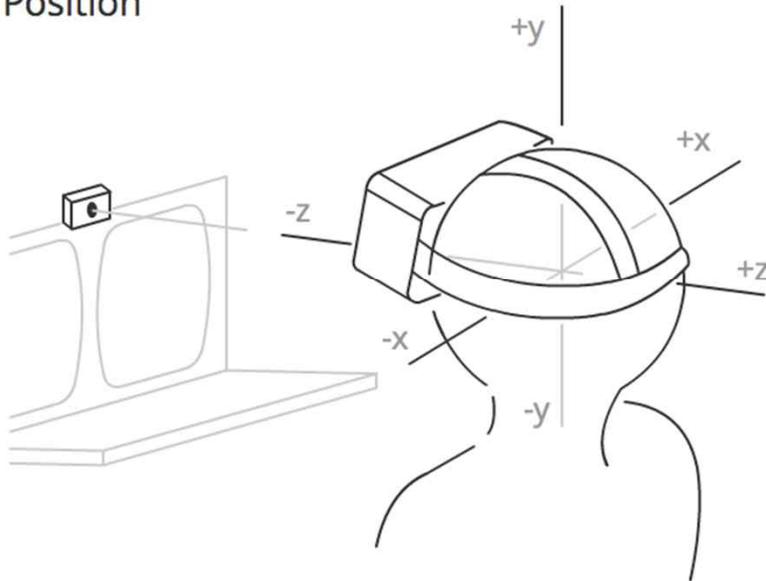
How to create stereoscopic 3D images



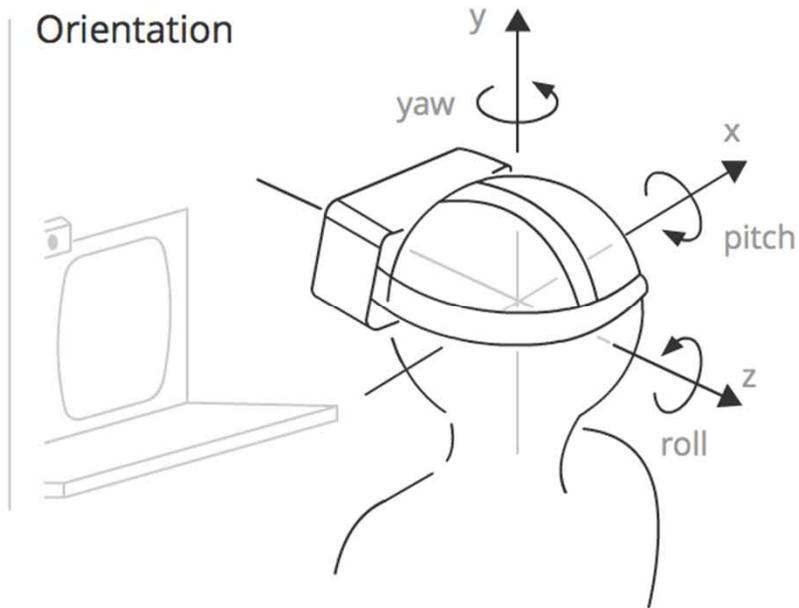
POSITION AND ORIENTATION

The position sensor detects information concerning the HMD and constantly outputs it.

Position

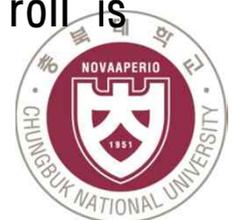


Orientation



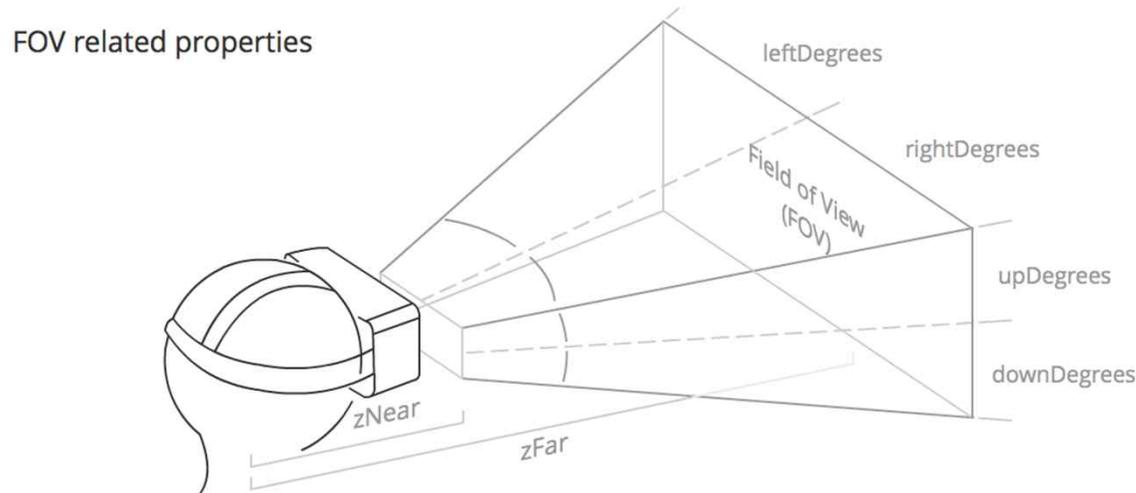
Position :The position of the HMD along three axes in a 3D coordinate space. x is to the left and right, y is up and down, and z is towards and away from the position sensor.

Orientation :The rotation of the HMD around three axes in a 3D coordinate space. Pitch is rotation around the x axis, yaw is rotation around the y axis, and roll is rotation around the z axis.



FIELD OF VIEW (FOV)

The field of view (FOV) is the area that each of the user's eyes can reasonably be expected to see.



- ✓ $upDegrees$: The number of degrees upwards that the field of view extends in.
- ✓ $rightDegrees$: The number of degrees to the right that the field of view extends in.
- ✓ $downDegrees$: The number of degrees downwards that the field of view extends in.
- ✓ $leftDegrees$: The number of degrees to the left that the field of view extends in.
- ✓ $zNear$: The distance from the middle of the user's head to the start of the visible FOV.
- ✓ $zFar$: The distance from the middle of the user's head to the end of the visible FOV.

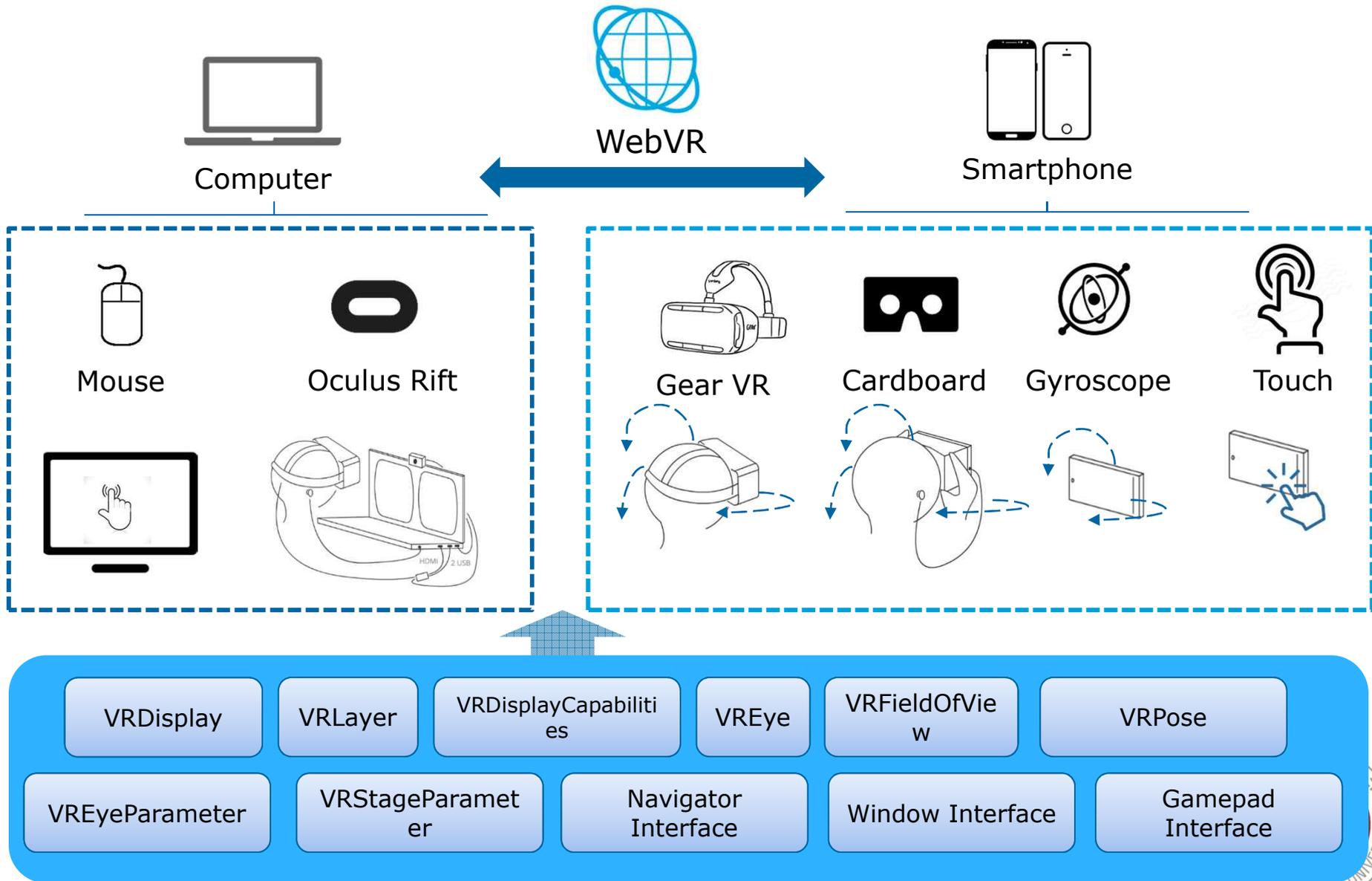


Specification of HMD Devices

Category	Gear VR	Oculus Rift	LG 360 VR	HTC VIVE	Sony PS VR
Display	2560x1440 1280 x 1440 per eye Super AMOLED	2160 x 1200 1080 x 1200 per eye OLED	1.88" IPS LCD x 2 EA, 920 x 720 per Eye, 639 ppi Real RGB	2560x1200 1080 x 1200 per eye OLED	1920 x 1080 960x1080 per eye OLED
Refresh rate	60 Hz	90 Hz	60 Hz	90 Hz	120 Hz, 90 Hz
Sensors	Accelerator, gyrometer, geomagnetic, proximity	Accelerometer, gyroscope, magnetometer, 360-degree positional tracking	6-axis (Gyro & Accelerometer) Proximity Sensor	Accelerometer, gyroscope, laser position sensor, front-facing camera	360 degree tracking, 9 LEDs
Field of view	96 degrees	110 degrees	Horizontal FOV (field-of-view) 80° lens	110 degrees	100 degrees
Controller	Bluetooth controller	Oculus Touch, Xbox One controller	G5 as handheld remote control	Vive Controllers, SteamVR controller, any PC-compatible gamepad	Sony DUALSHOCK 4 controller or PlayStation Move
Tracking area	Fixed position	5 x 11 feet	Fixed position	15 x 15 feet	10 x 10 feet
Minimum hardware requirements	Samsung Galaxy Note 5, Galaxy S6 series, or Galaxy S7 series	NVIDIA GeForce GTX 970 or AMD Radeon R9 290 GPU, Intel Core i5-4590 CPU, 8GB RAM, HDMI 1.3, 2x USB 3.0	LG G5	NVIDIA GeForce GTX 970 or AMD Radeon R9 290 GPU, Intel Core i5-4590 CPU, 4GB RAM, HDMI 1.3, USB 2.0	Sony Playstation 4



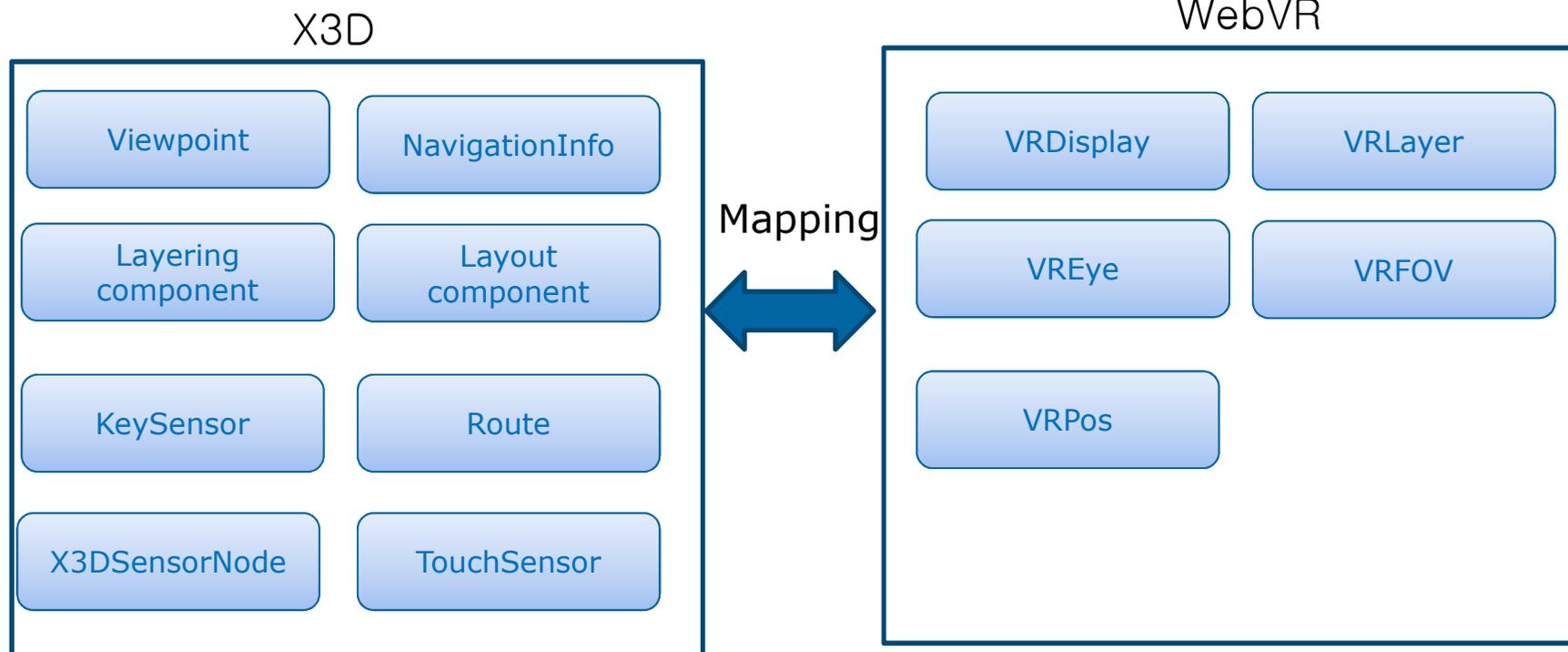
Global Scheme of WebVR



Considering X3D Node for HMD VR Services

X3D Nodes related to HMD VR services

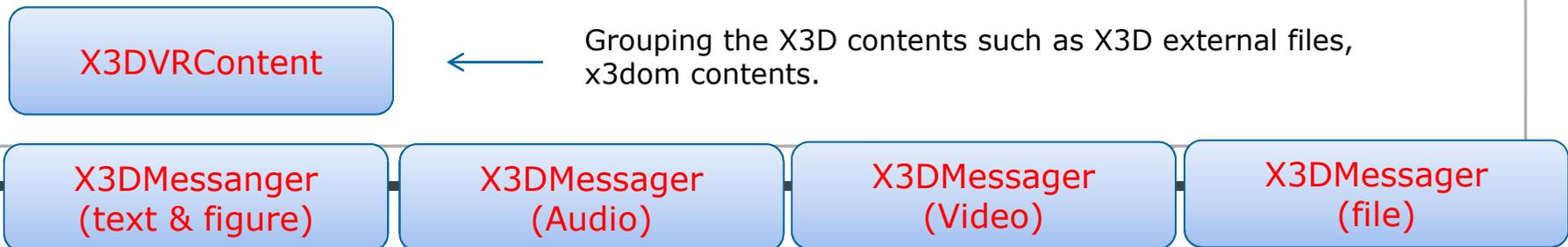
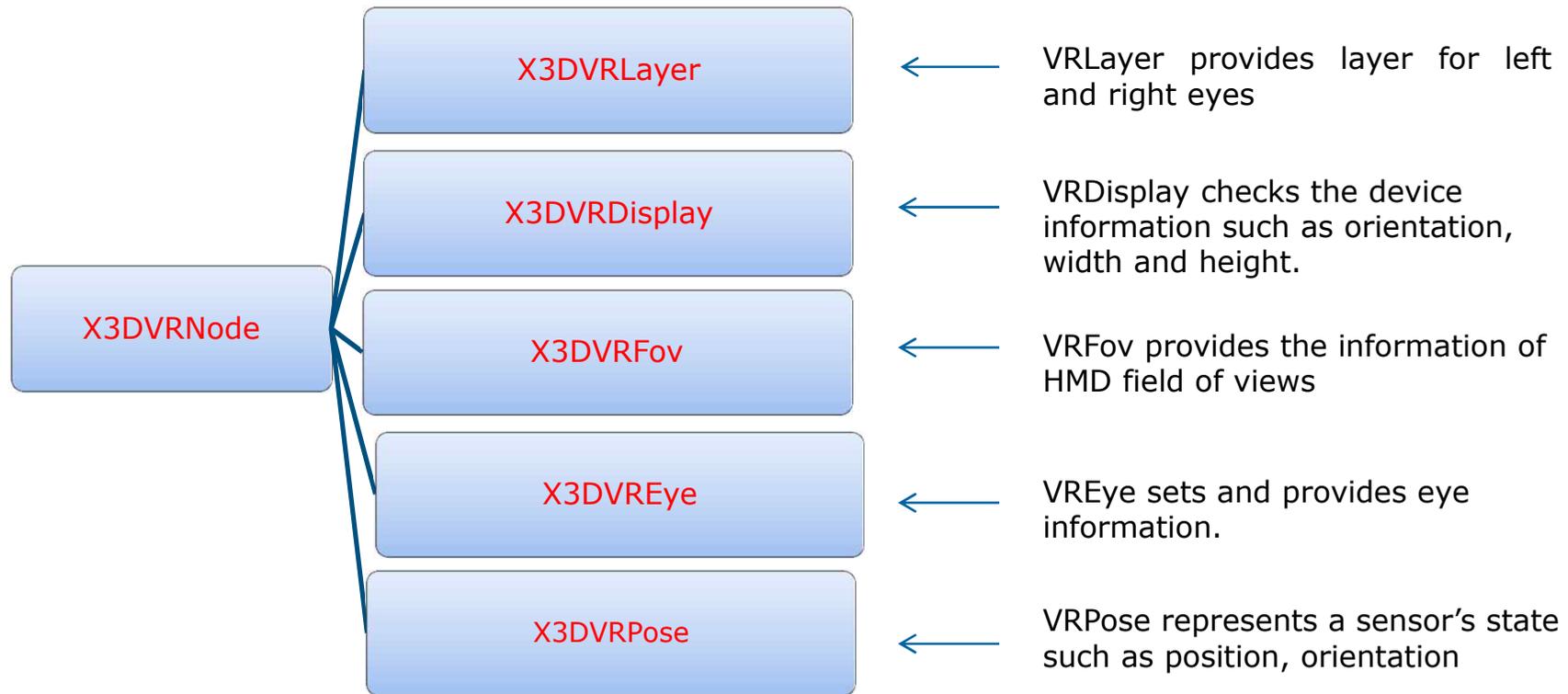
- Displaying VR
- Sensing Data to control VR



Considering X3D Node for HMD VR Services

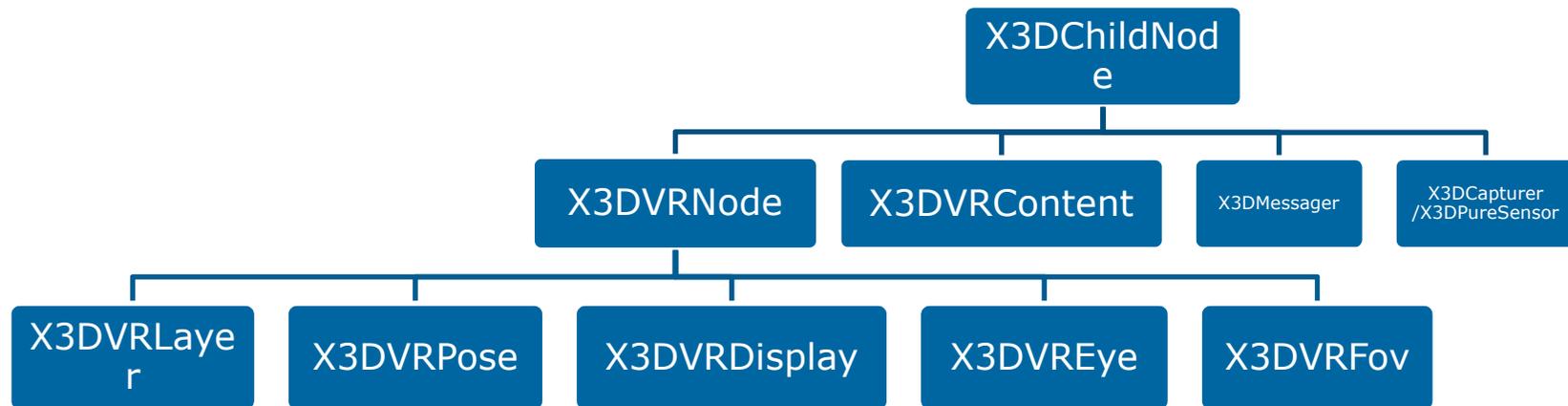
Profiles: VR profile (HMD VR)

- Displaying VR (Stereo rendering)
- Sensing Data to control VR

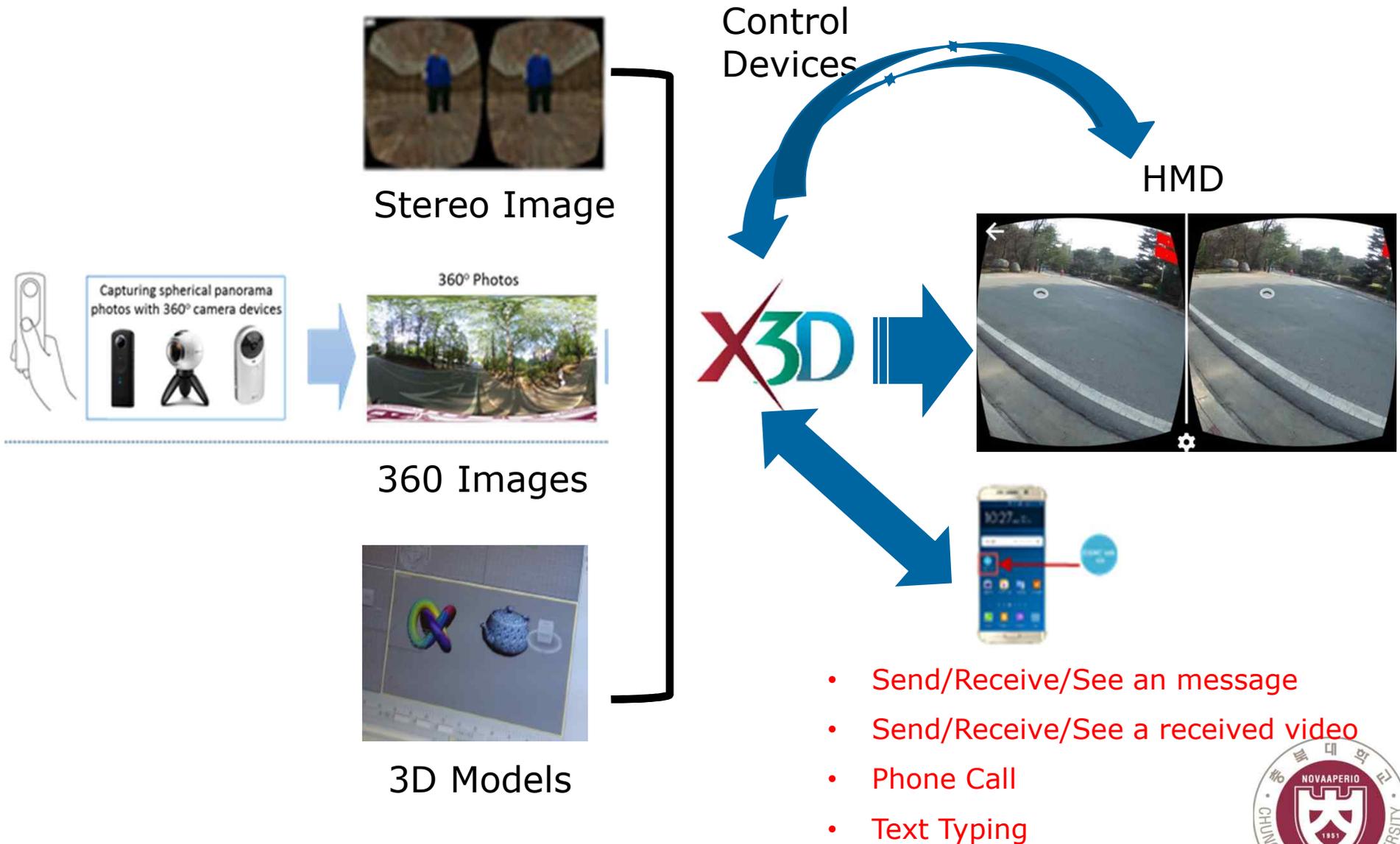


Considering X3D Node for HMD VR Services

Hierarchies of X3DVR



HMD VR service using X3D



HMD VR Service based on Stereo Video

Left image

Right image



stereoimage.jpg

Fisheye Lens

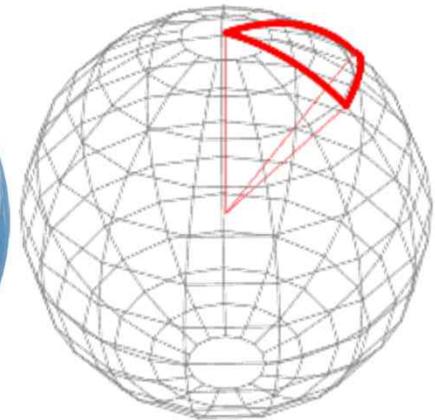
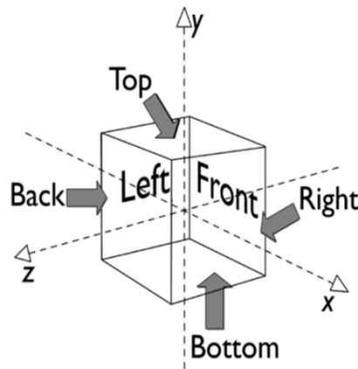
Image Distortion

Texture images



Panorama images for visualizing 360 scene

- 360° VR Tour app is composed by a panorama (pano) image, cubic and spherical
- A panorama image allows you to see the image from every angle including above, below, behind and next to you, that's the reason they are also called 360 images or spherical panoramas.



X3D Panorama image

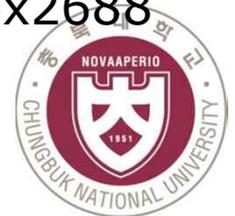
- Cubic : Skybox mapping (Background) (6 images)
: 3D provides panoramic background node for Universal media



- Equirectangular: Spherical mapping (360 image) Size: 2048x2048
: Sphere and Image Texture

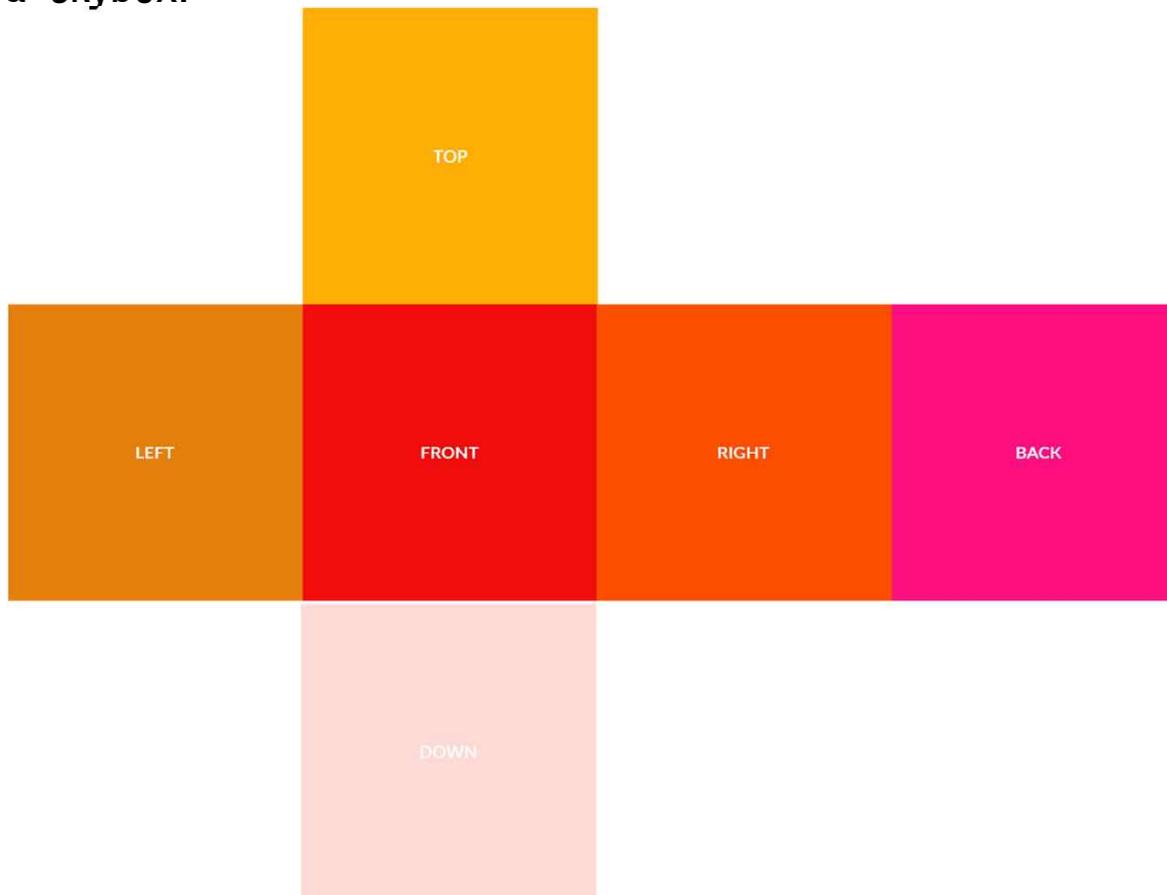


Size: 5376x2688



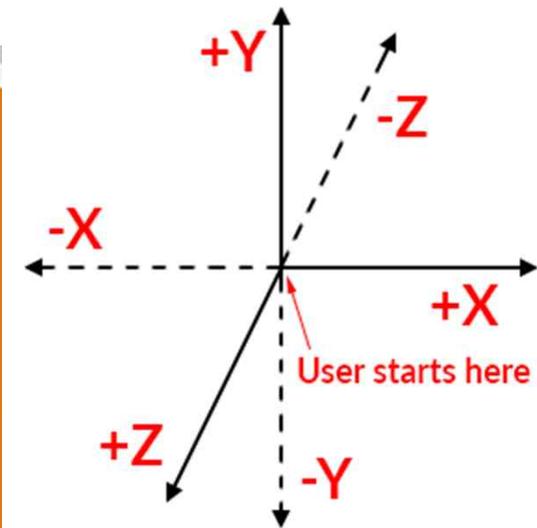
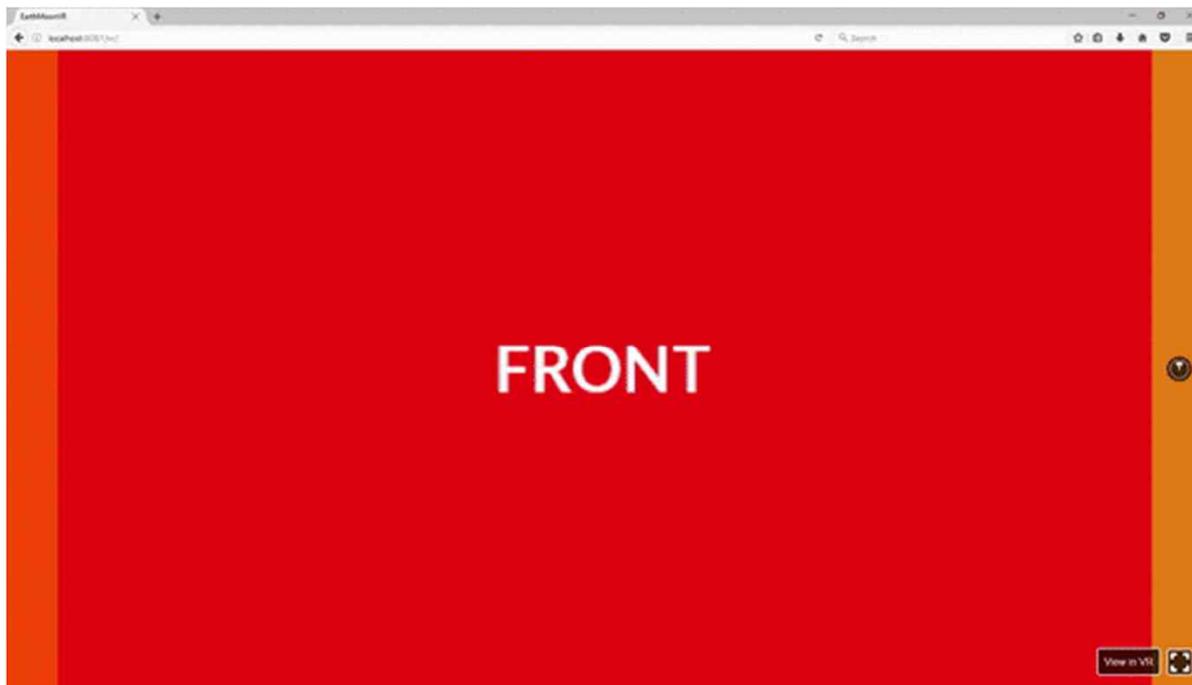
X3D Cubic panoramas

- Cubemaps are the other format of 360 panoramas. This format uses six images for the six faces of a cube that will fill the sphere around us. It's also known as a skybox.



X3D Cubic panos

- In 2D layouts, the X-axis points to the right and the Y-axis points down, which means that the top left is (0, 0) and the bottom right will be the width and the height of the element at (width, height).



X3D 360° image – cubic

- X3D provides panoramic background node for Universal Fields →

These are the X3D / X3DOM fields of this node. Values should usually be received / set as strings via DOM functions (i.e., using `setAttribute("myFieldName", "myFieldValue")` and `getAttribute("myFieldName")`).

Name	Type	Default Value	Range	Inheritance	Standard	Description
backUrl	MFString	[]	[URI]		X3D	
bind	SFBool	false		X3DBackgroundNode	x3dom	Pushes/pops the node on/from the top of the bindable stack
bottomUrl	MFString	[]	[URI]		x3dom	
crossOrigin	SFString	""		X3DBackgroundNode	X3D	Cross Origin Mode
description	SFString	""		X3DBackgroundNode	x3dom	Description of the bindable node
frontUrl	MFString	[]	[URI]		x3dom	
groundAngle	MFFloat	[]	[0, pi]	X3DBackgroundNode	X3D	Angle of the ground
groundColor	MFCColor	(0,0,0)	[0,1]	X3DBackgroundNode	X3D	Color of the ground
isActive	SFBool	false		X3DBackgroundNode	x3dom	
leftUrl	MFString	[]	[URI]		x3dom	
metadata	SFNode	X3DMetadataObject		X3DBackgroundNode	X3D	Field to add metadata information
rightUrl	MFString	[]	[URI]		x3dom	
skyAngle	MFFloat	[]	[0, pi]	X3DBackgroundNode	X3D	Angle of the sky
skyColor	MFCColor	(0,0,0)	[0,1]	X3DBackgroundNode	X3D	Color of the sky
topUrl	MFString	[]	[URI]		x3dom	
transparency	SFFloat	0/1	[0,1]	X3DBackgroundNode	x3dom	Transparency of the background



X3D 360° image – cubic

```
<X3D showStat='false' showLog='false' style='...'>
  <Scene DEF='scene'>
    <Viewpoint position="0 0 4"></Viewpoint>
    <Background id='back1'
      backUrl="'../img/cubic/pano_b.jpg'" bottomUrl="'../img/cubic/pano_d.jpg'"
      frontUrl="'../img/cubic/pano_f.jpg'" leftUrl="'../img/cubic/pano_l.jpg'"
      rightUrl="'../img/cubic/pano_r.jpg'" topUrl="'../img/cubic/pano_u.jpg'">
    </Background>

    <Transform>
      <Shape>
        <Appearance>
          <Material diffuseColor=".7 .7 .7" specularColor=".5 .5 .5" ></Material>
          <ComposedCubeMapTexture repeatS="false" repeatT="false">
            <ImageTexture containerField="back" url="../img/cubic/pano_b.jpg"></ImageTexture>
            <ImageTexture containerField="bottom" url="../img/cubic/pano_d.jpg"></ImageTexture>
            <ImageTexture containerField="front" url="../img/cubic/pano_f.jpg"></ImageTexture>
            <ImageTexture containerField="left" url="../img/cubic/pano_l.jpg"></ImageTexture>
            <ImageTexture containerField="right" url="../img/cubic/pano_r.jpg"></ImageTexture>
            <ImageTexture containerField="top" url="../img/cubic/pano_u.jpg"></ImageTexture>
          </ComposedCubeMapTexture>

          </Appearance>
          <Sphere solid="false" ></Sphere>
        </Shape>
      </Transform>
    </Scene>
  </X3D>
```



X3D 360° image – cubic



<http://cgac.cbnu.ac.kr/vr/pano/cubemap.html>



X3D Equirectangular panoramas

- An equirectangular pano consists of a single image with an aspect ratio of 2:1, meaning that the width must be twice the height.



Size: 5376x2688



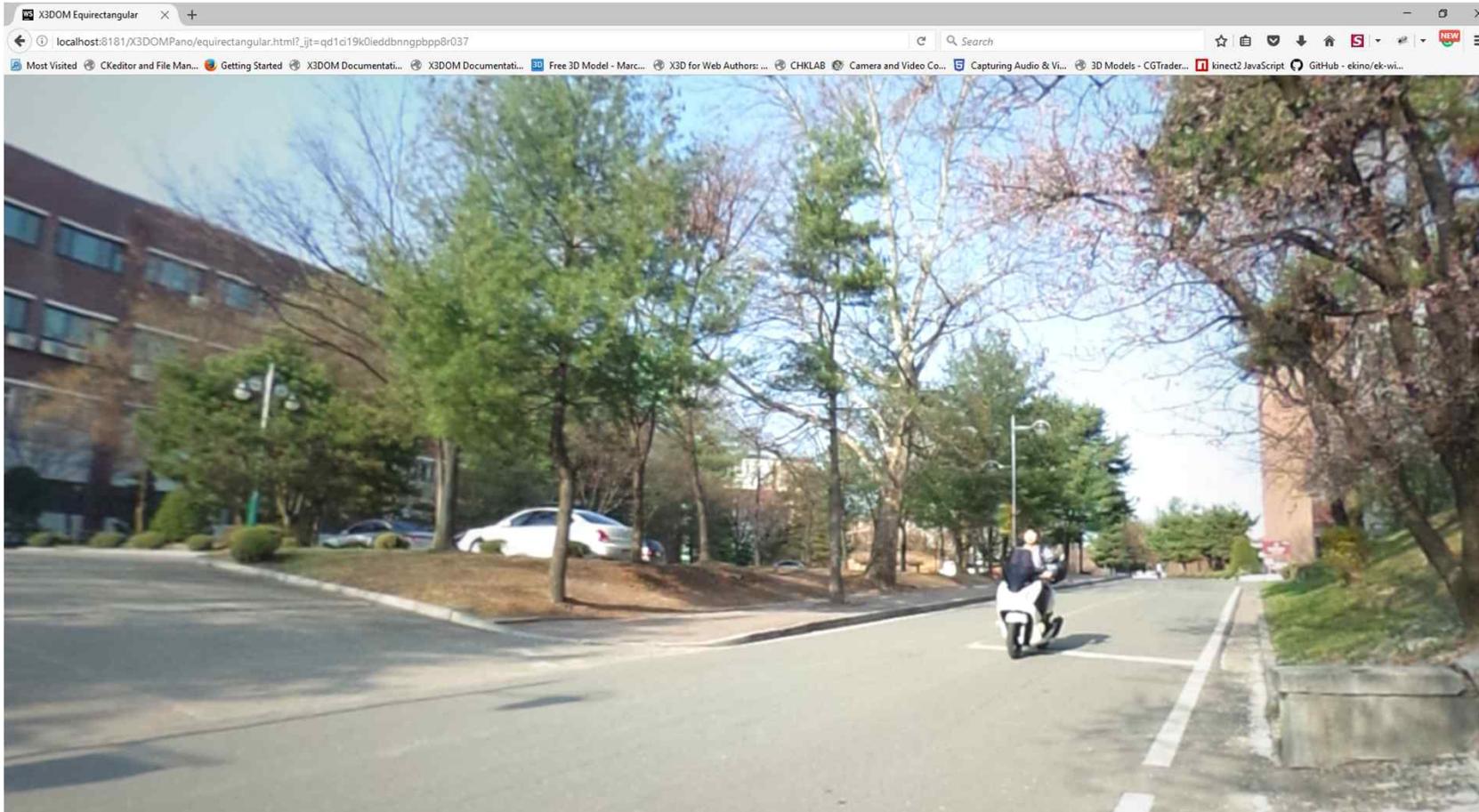
X3D 360° image – equirectangular

- Creating a sphere and using imageTexture to texture equirectangular image

```
<x3d id='x3dElement' showStat='false' showLog='false' style='width:100%; height:100%; border:0; margin:0; padding:0;'>
  <scene id='scene'>
    <NavigationInfo headlight='true' type="FLY" "WALK" "EXAMINE" "ANY"'/>
    <viewpoint id='vpp' def='vp' description='ViewPoint 1' centerofrotation='3.4625 1.73998 -5.55'
      orientation='0 1 0 2.99229' position='4.17102 1.00905 -6.97228'
      znear="0.001" zfar="300"'/>
    <background DEF='bgnd' skyColor="0 0 0"'/>
    <group id='root' render='true'>
      <transform DEF='dad_Group1' translation='0 1.6 0'>
        <shape DEF='Sphere1'>
          <appearance>
            <material DEF='Red' diffuseColor='1 0 0''/>
            <!-- Equirectangular image texture -->
            <imageTexture url="img/R0010213.jpg"'/>
          </appearance>
          <sphere DEF='GeoSphere1' solid='false' radius = 80'/>
        </shape>
      </transform>
    </group>
  </scene>
</x3d>
```



X3D 360° image – equirectangular



<http://cgac.cbnu.ac.kr/vr/pano/equirectangular.html>



360 VR Tour – Navigation

- Move to the next scene
- Focus on the icon or click
- Show the next place' s name

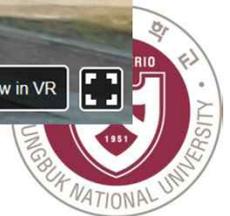
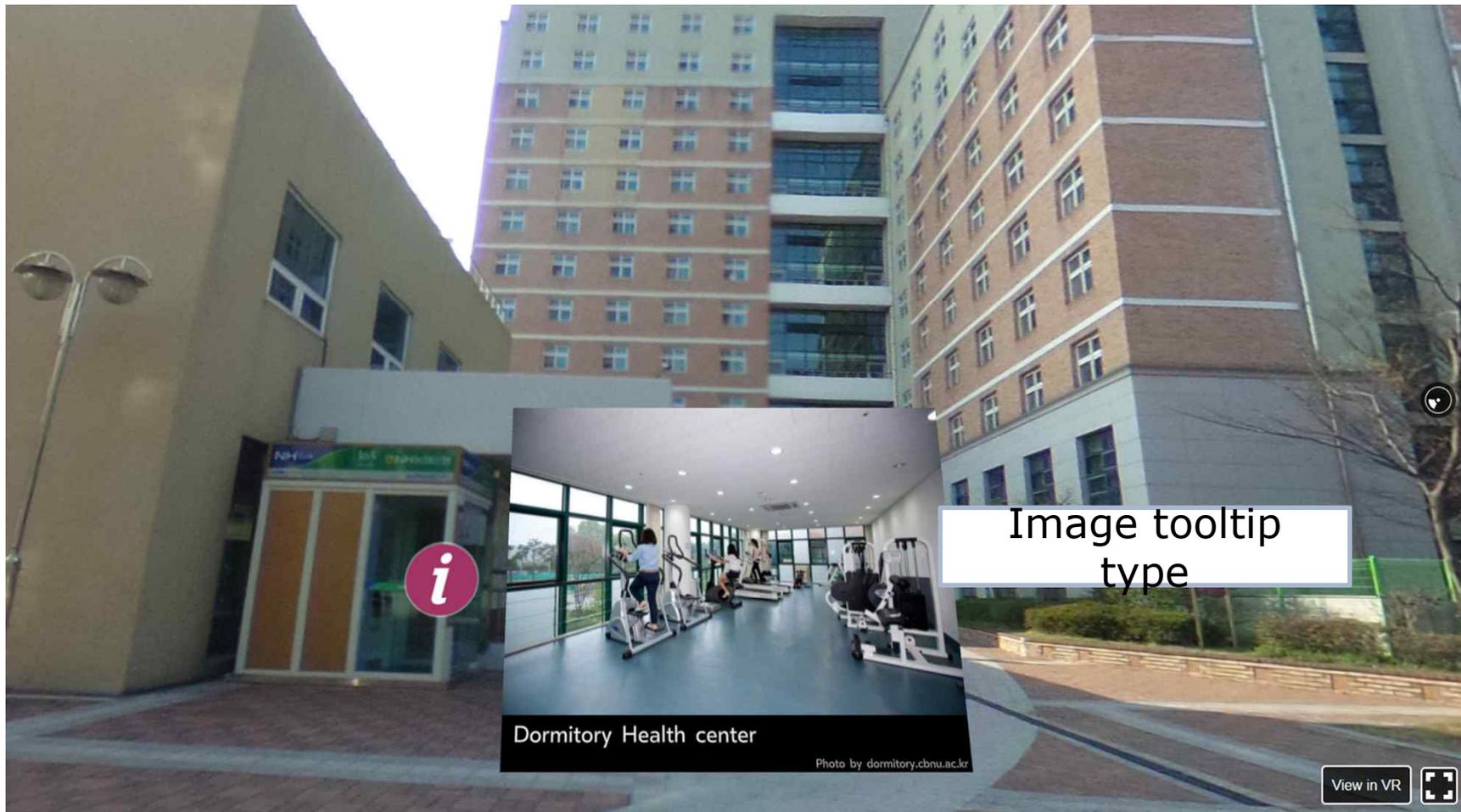


 Main Building



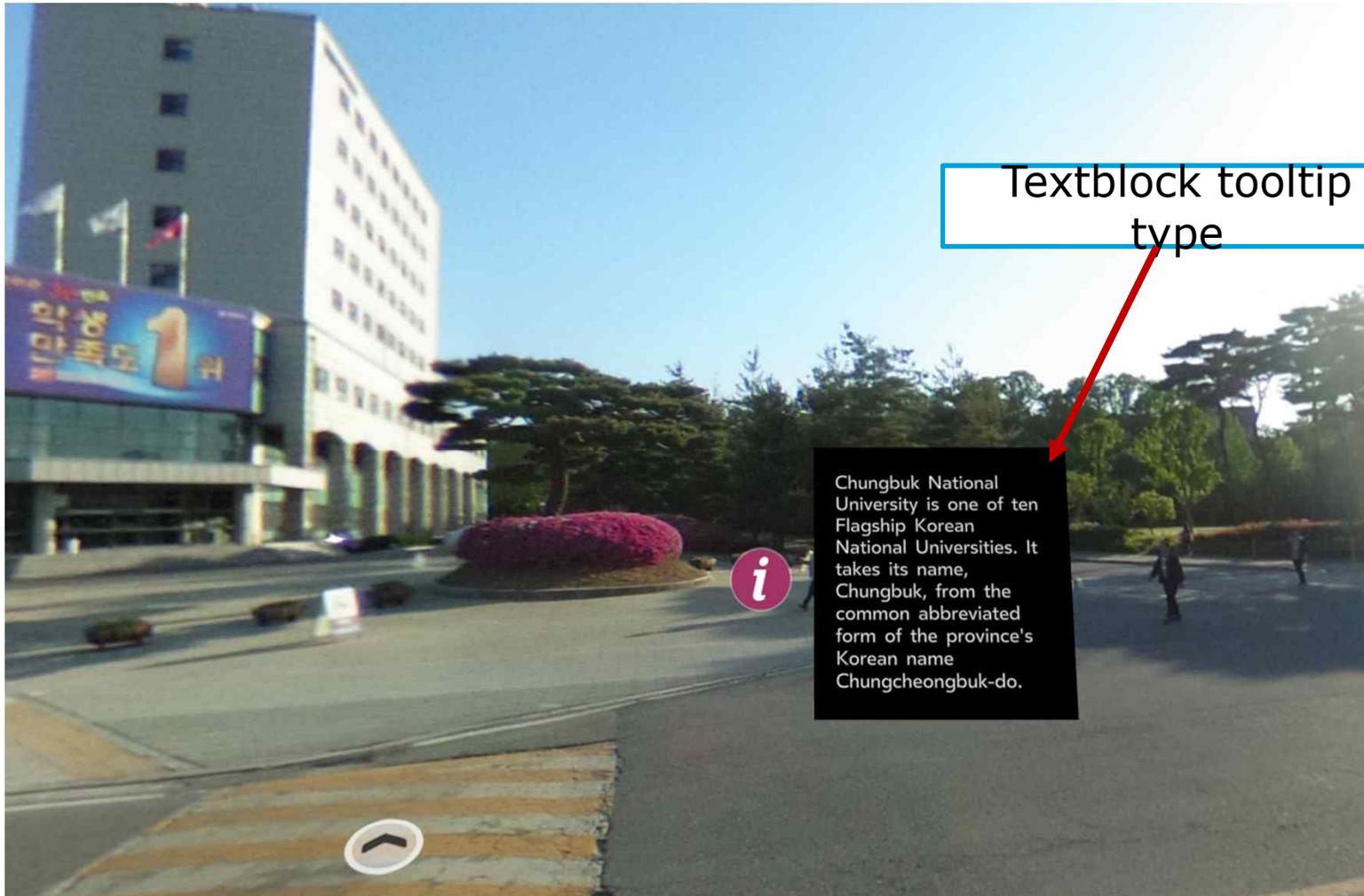
360 VR Tour – Tooltips

- Information icon
- Image tooltip type (attribution, attributionUri, width, height)



360 VR Tour – Tooltips

- Textblock tooltip type (text, width, height)



360 VR Tour – Tooltips

- Video tooltip type (source, width, height)



Seamless Message Supporting Service through Phones

- Send/Receive/See an message
- Send/Receive/See a received video
- Phone Call
- Text Typing
- Transmission of files



Considering X3D Node for HMD VR Services

Profiles: VR profile (HMD VR)

- Displaying VR (Stereo rendering)
- Sensing Data to control VR

X3DVRContent

← Grouping the X3D contents such as X3D external files, x3dom contents.

X3DMessenger
(text & figure)

X3DMessenger
(Audio)

X3DMessenger
(Video)

X3DMessenger
(file)

Conclusion

- ✓ Render a VR scene based on X3D
- ✓ Interaction of X3D VR scene and HMD devices
- ✓ Provide seamless services while seeing X3D VR scene



Q&A