

Research Seminar: Cognitive Science

Starting Computer Graphics for VR

6/Mar/2019

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Devices of Virtual-Reality (VR)

- **Head-mounted display:** a pair of small displays (one for each eye; e.g. Oculus-rift, HTC-Vive, Sony-PS-VR, Google Cardboard)
- **Large display (or displays)** with stereo-shutter/polarized glasses (e.g. CAVE)



<http://www.techworld.com/picture-gallery/cloud/virtual-reality-gets-real-3400143/>

VR Head-Set

We mostly consider a VR head-set with a smartphone (e.g. Google daydream) in this workshop. We can do some VR thing with this device but it surely has some limitations.

- 1) Smaller field of view
- 2) Limited head-tracking (only rotation and no translation)
- 3) Limited interaction

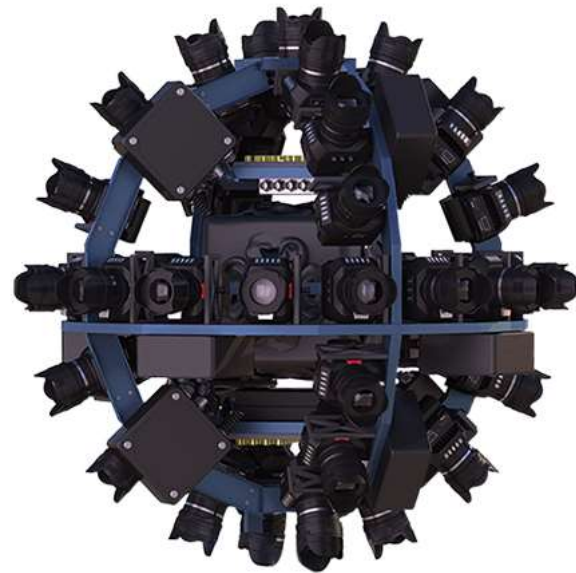


Making VR Contents: Video/Camera

- Stereo camera
- Panorama/360° camera
- 360° stereo camera



 [Mme de Sévigné](#)



<https://www.youtube.com/watch?v=7wde7bNLnlg>
<http://blog.herigo.com/vr-kameralar-hakkinda-merak-edilenler/>
<https://newatlas.com/panono-throwable-panorama-camera/29761/>
<https://filmora.wondershare.com/video-editing-tips/vr-players-for-pc.html>

Making VR Contents: 3D Computer Graphics

- CG Software {
- Unity {
1. Modeling objects
 2. Specifying materials of the objects and their textures
 3. Composing a scene with the objects, lights, camera
 4. Rendering an image (or images) of the scene

Almost all 3D computer graphics software has functions for all steps but most of them do not have functions for VR in steps 3 and 4. For VR, we use the software only for steps 1 and 2.

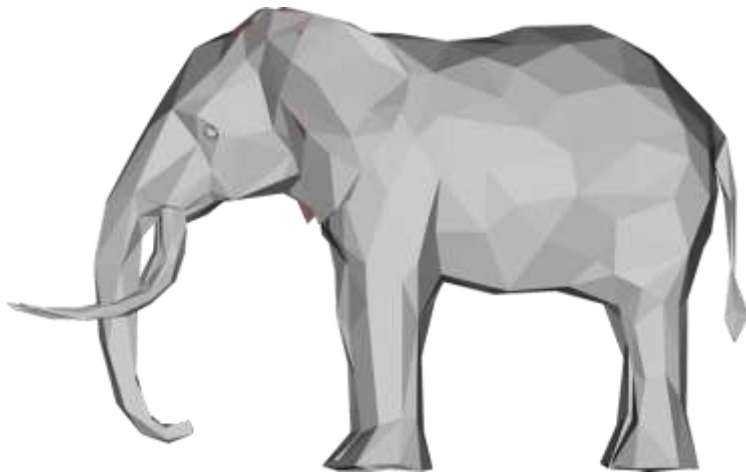


(Note that Unity has very limited modeling functions.)

Modeling 3D Shapes of Objects

- Different software provides different tools for modeling: e.g.
<https://app.sketchup.com/app>
<https://stephaneginier.com/sculptgl/>
3D Viewer & 3D Paint of Windows 10

Almost all software represents a 3D shape as a set of polygons. Some software has their special functions for some objects that are hardly represented by polygons (e.g. hair). 3D information based on these special functions is hardly shared across software.



Modeling 3D Shapes of Objects

- 3D model library

<https://free3d.com/>

<https://clara.io/>

<https://archive3d.net/>

<https://www.turbosquid.com/>

Check availability of data for research project.



Free
max obj fbx oth



Free
max obj fbx



Free
max obj fbx oth



Free
max fbx



Free
blend



Free
3ds max obj fbx



Free
3ds max obj fbx dae ztl



Free
max obj fbx



Free
ma obj fbx blend oth



Free
max obj fbx oth



Free
ma max obj fbx



Free
3ds obj X fbx blend dae

Modeling 3D Shapes of Objects

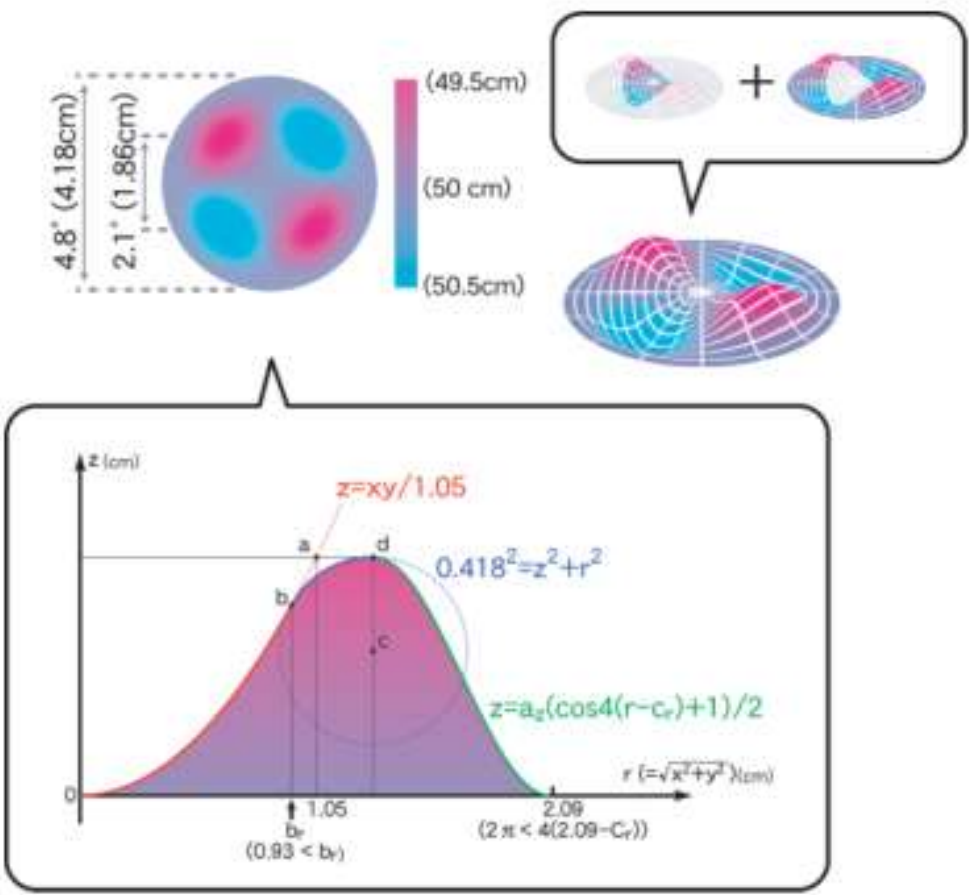
- Programming for random or mathematically-specified shapes
- DXF file format represents a 3D shape with text data
- Octave/Matlab can export a DXF file

```

dxfl example.dxf - Notepad
File Edit Format View Help
ENDSEC
0
SECTION
2
ENTITIES
0
LINE
5
151
330
1F
100
AcDbEntity
8
0
100
AcDbLine
10
15.6406756555219
20
38.24096412579857
30
0.0
11
25.02757389848606
21
29.80544722513349
31
0.0
0

```

Name of object → LINE
X coord of start point → 10
Y coord of start point → 15.6406756555219
X coord of end point → 30
Y coord of end point → 38.24096412579857



“Texture” in 3D Computer Graphics

“Texture” in 3D Computer Graphics refers materials, surface properties, and so on. There are many common properties of the texture (e.g. Lambertian, specular, mirror-reflection, transparency for each RGB channels and bumps) across software but also many properties for specific software.

https://www.google.com/search?newwindow=1&safe=strict&rlz=1C1GGRV_enRU751RU751&tbm=isch&q=3D+CG+teapot+texture+&chips=q:3d+cg+teapot+texture,online_chips:computer+graphics&sa=X&ved=0ahUKEwi9mNaFpOvgAhUqp4sKHxoEAIMQ4IYIKygD&biw=1413&bih=821&dpr=1



(See Greenberg, 1989)

“Texture” in 3D Computer Graphics

There are some physical properties Unity or other software can hardly simulate and some physically-impossible properties they can generate.

Transferring a 3D Object across Software

There are some common file formats for 3D data from one software to another software. For example, Unity can load **.fbx**, **.dae** (Collada), **.3ds** (3D Studio Max), **.dxf**, and **.obj** files (<https://docs.unity3d.com/Manual/3D-formats.html>). However, it does not mean all the properties in some software are transferred to another software. For example, 3D Studio Max is professional 3DCG software and has a lot of functions. Even if its 3D file (.3ds) is loaded by Unity, sub-set of the properties can be loaded.



Properties of Light

<https://docs.unity3d.com/Manual/Lighting.html>

Properties of Camera

Position and direction; Orthographic or Perspective; Pinhole-camera or with aperture; Visual angle; Focus distance;



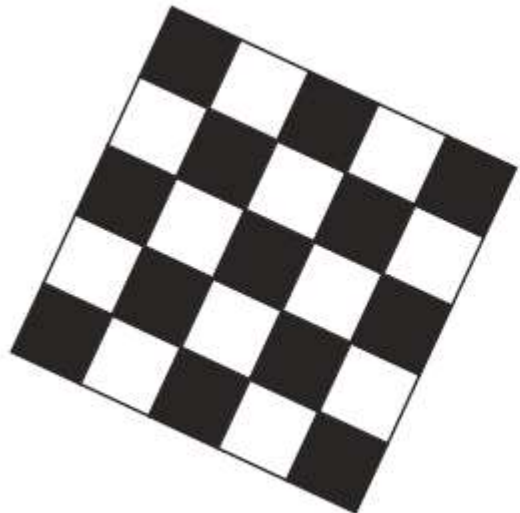
Rendering

- Pre-rendering: Any 3DCG software for VR movie can be fine. You can find many on Youtube.
- Real-time rendering: Unity, Unreal-engine, and so on

For real-time rendering, you need to consider speed.

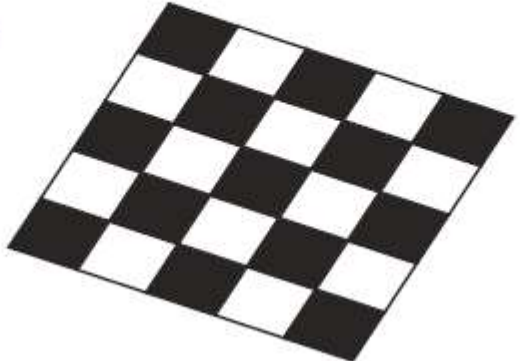
Camera

(a)



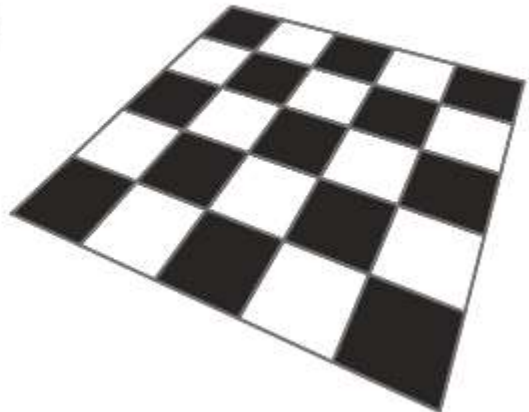
Frontoparallel view of a plane

(b)

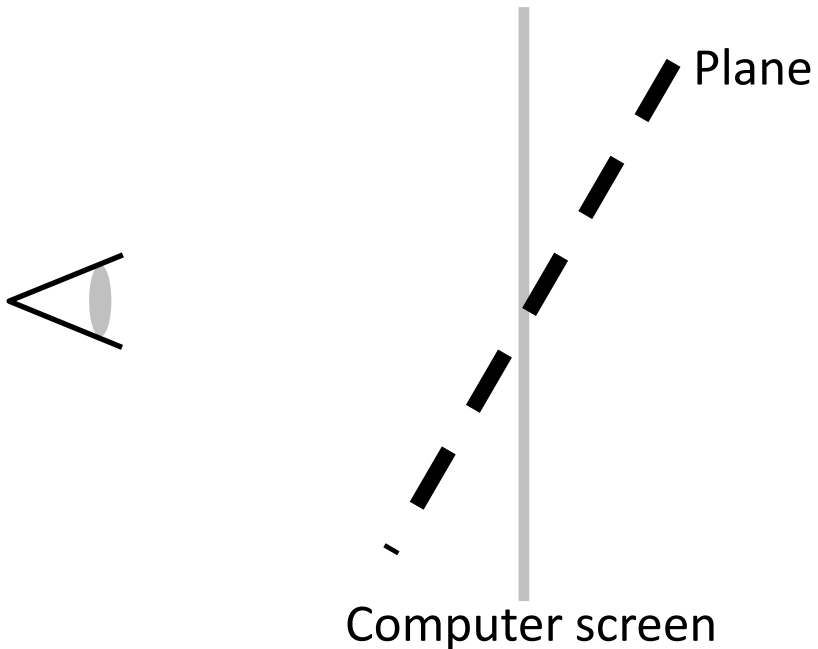


Orthographic image of the plane (a) being slanted

(c)



Perspective image of the plane (a) being slanted



Computer screen