Modern Technologies

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History

History of Lara Croft

Now

Not just the number of polygons
Light

Significant role in 3D games.

**RYSE: Son of Rome** scene with and without lighting:
Lightsources

1. Directional light:
   No falloff

2. Point light:
   Has falloff

3. Spot light:
   Has falloff, funnel shape

4. Ambient light:
Lightsources

Area lights - real world light sources, have shape and size.
https://www.youtube.com/watch?v=ZLRgEN7AQgM

Article:  https://eheitzresearch.wordpress.com/415-2/
Shading

Early games:
- Baked
- Simplistic light model (eg. Phong)
Shading

Surfaces tend to look more plastic compared to modern games
Shading

Physically-Based rendering (PBR) - more physically correct computations
Shading

**Metalness** - is the material metal or nonmetal
Shading

Energy conservation - object can not reflect more light than it receives.
Shading

**Fresnel** - the percentage of light that a surface reflects at grazing angles.
Shadows

**Shadow mapping** - the scene is rendered from the perspective of the light source (shadow map).
Shadows

The quality depends on the resolution of the shadow map.
Shadows

**Cascaded Shadow Maps** -> multiple shadow maps with different resolutions. (More precision close to camera)
Global Illumination

Global Illumination (GI) - ambient light bouncing off the surfaces
Global Illumination

Static lightmaps (Raycasting)

It can be done in real-time but it is very very slow.
Global Illumination

Unity -> **Enlighten**

Baked static geometry + dynamic light sources
Global Illumination

Unity -> **Enlighten**

**P.A.M.E.L.A**

*Player Controlled Lighting*
Global Illumination

Unity -> Enlighten

Only static geometry can bounce light, to receive it light probes have to be added.
Global Illumination

Both Unreal and Cryengine have real-time *voxel cone-tracing* GI solutions. -> too slow for older computers

Unreal engine elemental demo [https://www.youtube.com/watch?v=MOvfn1p92_8](https://www.youtube.com/watch?v=MOvfn1p92_8)
Reflections

**Planar reflections** - camera renders scene below the surface

Performance expensive, only works with planar surfaces (not so good for wavy water).
Reflections

Reflection probes - the surrounding is rendered to a cubemap.

Good results near the reflection probe.

More information about cubemaps.
Reflections

**Screen space reflections** - reflections sampled from already rendered scene.

Artifacts near the edges
Fog

Historically used to hide limited render distance

Adds sense of depth
fog

Fog particles
Fog

**Volumetric fog** - reflects ambient light, creates light rays
Fog

**Volumetric fog** - reflects ambient light, creates light rays

Unity implementation: [https://github.com/Unity-Technologies/VolumetricLighting](https://github.com/Unity-Technologies/VolumetricLighting)
Particles

Large number of tiny sprites or objects - simulate “fuzzy” phenomena
Particles

Can be used in game logic - Zombie boids
Particles

Modern particles:
- Emit light
- Collide with room geometry
- Distort scene behind

GPU particles -> only in Unreal Engine
Post effects

**Postprocess effects** - applied after the whole screen has been drawn.
**Deferred shading** - light calculations are done in post effect.

- **Albedo color**
- **Surface normals**
- **Depth buffer**
- **Material roughness**
Post effects

Resulting image with other post effects
Other post effects

**Depth of field** - blurs objects in the distance
Other post effects

**Ambient occlusion** - darkens corners and cavities
Other post effects

**Ambient occlusion** - darkens corners and cavities

SSAO Pro
Other post effects

**Bloom** - makes light pixels bleed out of their boundaries

[Unity natural bloom](#)
Other post effects

**Distortion** - distorts and curves the whole image

[Image: Distortion shader]
Conclusion

This was just a small selection of modern 3D techniques

Learn more how GTA 5 effects and optimizations:
http://www.adriancourreges.com/blog/2015/11/02/gta-v-graphics-study/

To become a master - Come and study Computer Graphics (MAT.03.015)