3D Stereoscopic Game Development

How to Make Your Game Look Like Beowulf 3D

3D Stereoscopic Has Gone Mainstream

3D Enabled Cinemas are Growing
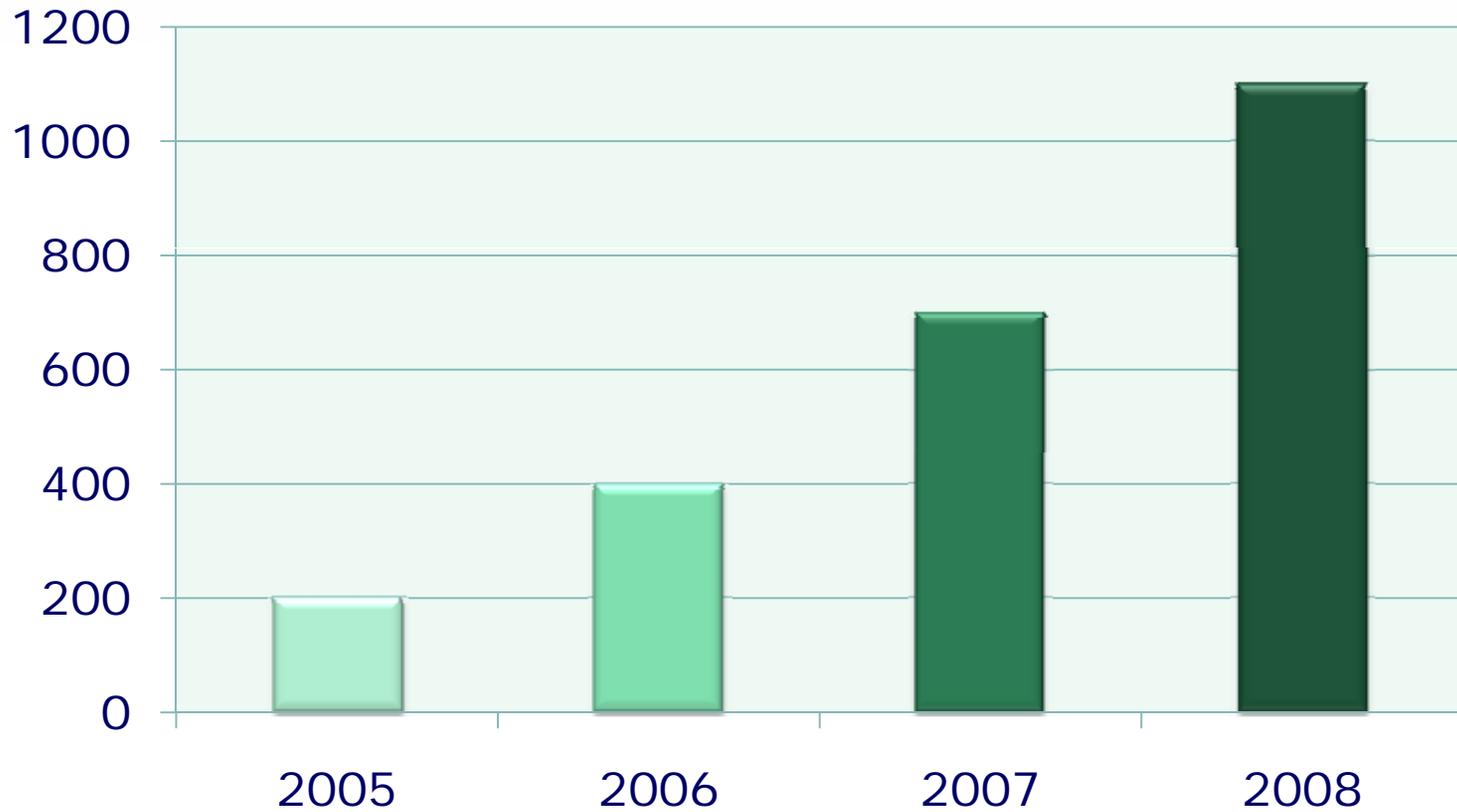
For Consumers Looking for an Immersive Gaming Experience at home, PCs are the only choice!

Agenda

- Basics of 3D Stereo on a PC

- NVIDIA GeForce 3D Stereo drivers

- Maximizing 3D Stereo in Your Game

- How We Can Help

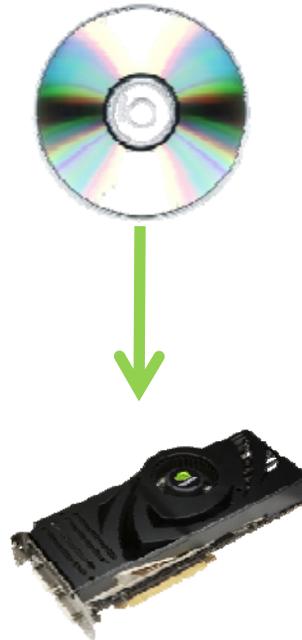# Basics of 3D stereo on a PC

- Step 1: GPU processes data from an application and starts the rendering process.

Basics of 3D stereo on a PC

- Step 2: The GPU and driver uses W coordinate data to create two different images which are offset from each other and stores them in the frame buffer.
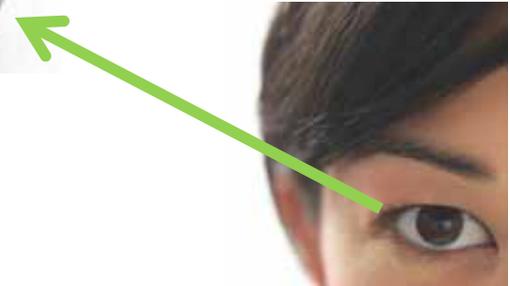

Image 1: Left eye

Image 2: Right eye

Basics of 3D stereo on a PC

- **Step 3**: The GPU then renders both offset frames on a display. The viewing device is what determines how the images are processed for the viewer.

3D Stereo Displays

- Two different techniques for viewing:
  - Active shutter glasses
  - Passive glasses and LCDs with polarized filters

- NVIDIA drivers will support passive glasses at launch. Active shutter glasses is currently a technology demo.

- For our talk, we will focus on passive glasses on LCDs with polarized filters.

LCDs with polarized filters and passive glasses

- Uses different light polarization for left and right eye images.
- Left and right eye images are interleaved in odd and even lines of the screen
- Glasses with polarized filters allow one of the images to pass through and block the other.

Zalman ZM-M220W (22")
1680x1050

Zalman displays

- Zalman site www.zalman.com
- Distributed in US by Quiet PC USA
    - ZM-M190   (19") - 1280x1024
    - ZM-M220W (22") - 1680x1050
- Please contact
    - Quiet PC USA
    - Steve Farnsworth
    - Sales Manager
    - Tel. 530-274-7766
    - Fax. 530-274-7702
    - Email : steve@quietpcusa.com
    - Website : www.quietpcusa.com

GDC On-Site Demos

- NVIDIA (NH ES658)

- Zalman (NH 6705)

- Texas Instruments

NVIDIA GeForce 3D Stereo Drivers

- Windows Vista 32-bit only

- No new Windows XP support

- Download from www.NVIDIA.com/drivers or www.nvidia.com/object/3dstereo_drivers.html

- Detailed instructions for enabling stereo are included in the appendix.

GeForce 3D Stereo Settings End Users Can Configure

- **Depth Amount setting** represents the *maximum stereo separation*, which is applied to far objects.

- Stereo separation is the distance between left and right eye images of the same object.
  - Maximum stereo separation should be equal to the distance between the pupils of a persons' eyes (about 2.5 inches).
  - Some people may feel uncomfortable with a high stereo separation, so it's default is 15% of the maximum.
  - Most users will raise it to higher value after adjusting their eyes to using 3D stereo
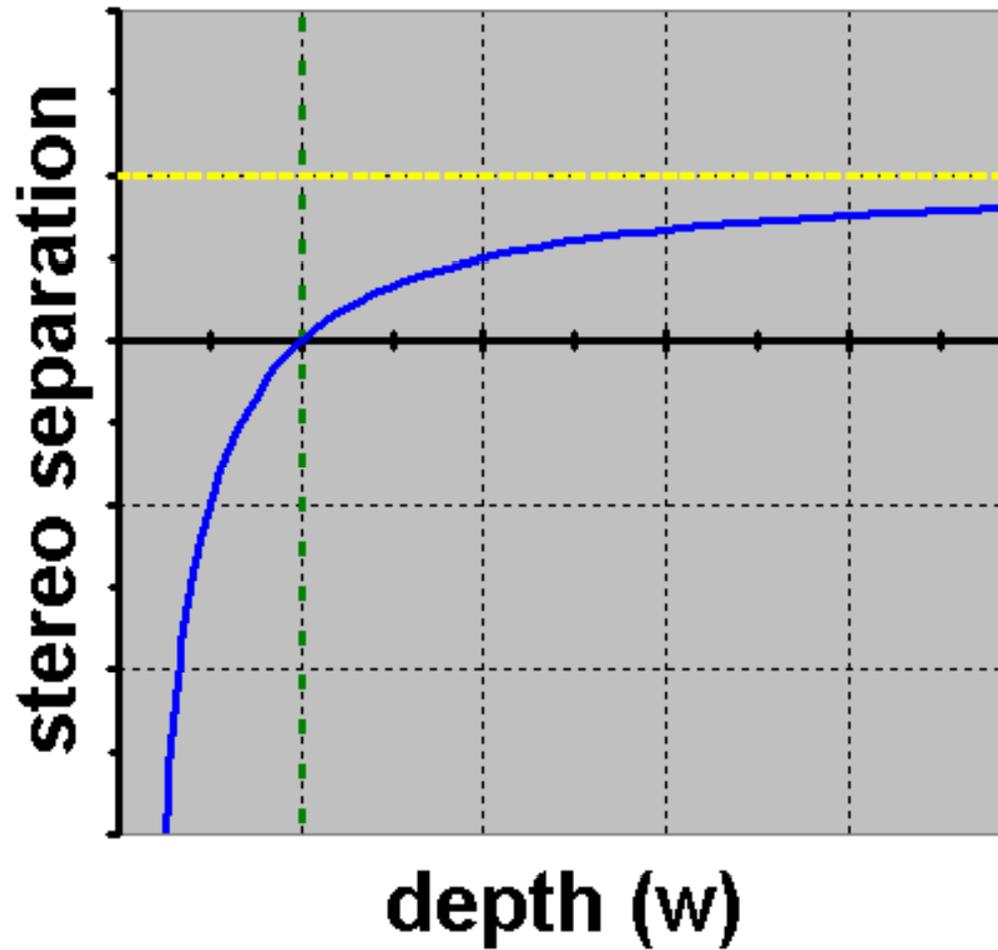
Stereo Separation

Stereo Separation
(continued)

- If stereo separation = 0, an object appears at screen depth.

- Distant objects have separation quickly approaching maximum, as a function of 1/W.

- Maximum separation is the distance between the pupils of a persons' eyes (appx. 2.5 inches).

Zero separation depth

- Zero separation depth (screen depth) is controlled via **Convergence adjustment** hotkeys.

- Keys can be set at

  3D Stereo CPL -> Advanced 3D Stereo Properties -> Configure Hotkeys

- Officially supported games have optimal Convergence values pre-configured in profiles shipped with our drivers.

Getting ready to test your game

- To test a new game in stereo, a game specific profile needs to be created.

- Detailed instructions are included in the appendix.

NVIDIA GeForce 3D Stereo
driver from a programmer's
point of view…

GeForce 3D Stereo implementation in driver

- Swapchain and certain textures are created with left and right eye representations.
- Draw calls are executed twice, once rendering into the left and once into the right eye representation.
- Vertex shaders passed by the application are modified by NVIDIA driver to apply the stereo effect:
  - Stereo separation is computed from W coordinate (depth).
  - It is then either added or subtracted from X coordinate.

Stereo in intermediate textures

- In StereoTextureEnable=1 mode a texture will have left and right eye representation if the following two conditions are met:
  - Not square (width != height)
  - Are of the same size as backbuffer or larger.
- This is result of the following considerations:
  - Stereo needs to be applied also to offscreen buffers, so at least some textures should get stereo effect.
  - However, not all textures should have it. For example, shadowmaps (shadows fall the same regardless of whether you look at them from left or right eye POV).

Stereo in intermediate textures (cont.)

- When developing an app, follow these rules:
  - If rendering from POV of a camera/player, render to backbuffer or a texture of the same size as backbuffer.
  - If doing postprocessing step(s), make sure subsequent destination textures are also of the same size.
  - If rendering from POV of a lightsource or other situation which needs stereo effect turned off for the whole scene, and does not need separate left and right eye representation, render to a square texture.

Rendering 2D objects

⊕ 2D objects are typically HUDs, menus, or text messages which should ideally be at screen depth with no stereo effect.
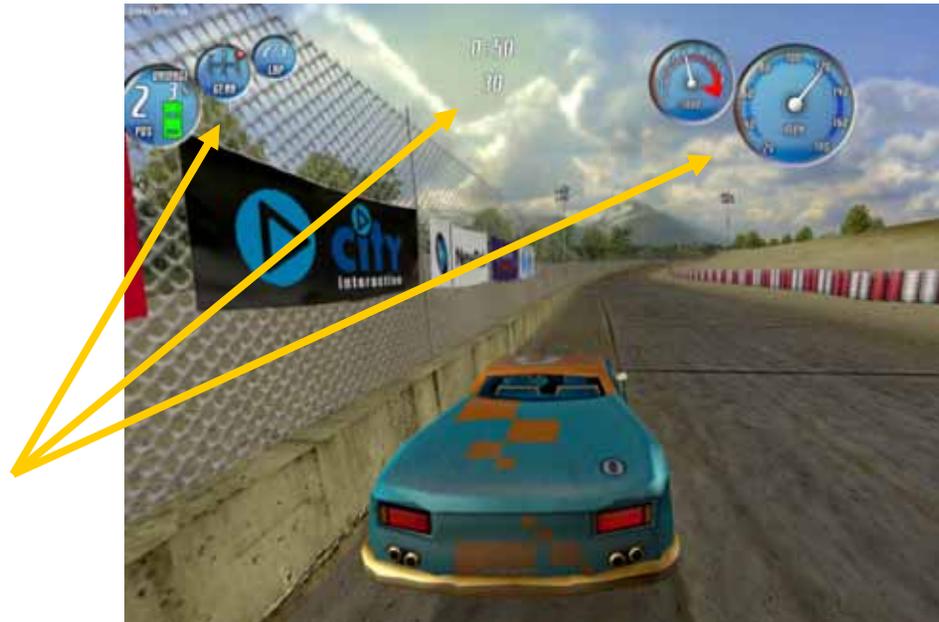
⊕ To render a 2D object, with no stereo effect, set W coordinate to 1.0

Example: postprocessing

- Scene is rendered to a texture, and has stereo effect applied at that time.
- Make sure destination texture has the same size as backbuffer so that it has left and right eye representations.
- Then you render a full screen quad from that texture, either to a backbuffer, or another texture.
- If both source and destination textures have left and right eye representations, then 2 rendering operations will occur: left->left and right->right.
- To make sure that no additional stereo separation is added when rendering a full screen quad, set W=1 on all vertices.

Maximizing 3D Stereo in your Game

Placing objects at correct depth

- Our eyes use multiple cues to determine distance to an object.
- Stereo separation is only one of them.
- If object A is obscured by object B, it is a strong hint that object A is further away.
- When stereo separation contradicts with other depth cues, eyestrain and headache will result.

Examples of incorrect rendering

- Skybox rendered at the beginning of the scene, with Z write disabled, and some random W value, unrelated to the rest of the scene.

Stereo tip

When rendering skybox or other background objects, use W value larger than the rest of the scene!

More examples of incorrect rendering

- Object/NPC highlights, hit-point bars, etc. rendered not at the same depth(W) as the object being highlighted.

Object hit points/name/etc

Object

Even more examples of incorrect rendering

- A gun rendered at the end of the scene, after Z buffer from the main scene rendering has been cleared, and using W range significantly overlapping with the main scene.

Stereo tip

Try to make sure it renders fine with Z buffer remaining from the main scene, using the same matrices.

Make sure your projection matrices are consistent across the whole scene!

Crosshairs

- 2D crosshair does not work in 3D stereo.
- Lasersight works in stereo.

Stereo tip

Draw the crosshair and lasersight at the right depth of the object.

Maximizing stereo effect

- Maximum stereo separation is about 2.5″, and represents 100-200 pixels.
- Stereo separation quickly approaches maximum, as a function of 1/W:
  - For example, if you start at W=10 being your screen depth (zero stereo separation), then at W=1000 stereo separation will be within 1 or 2 pixels of the maximum.

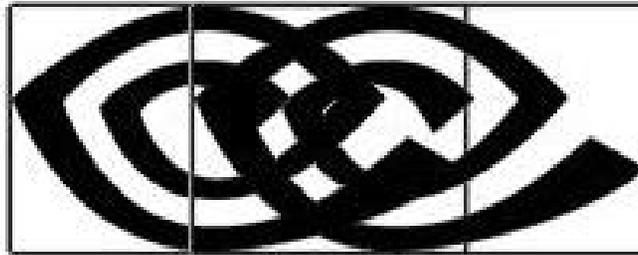stereo separation
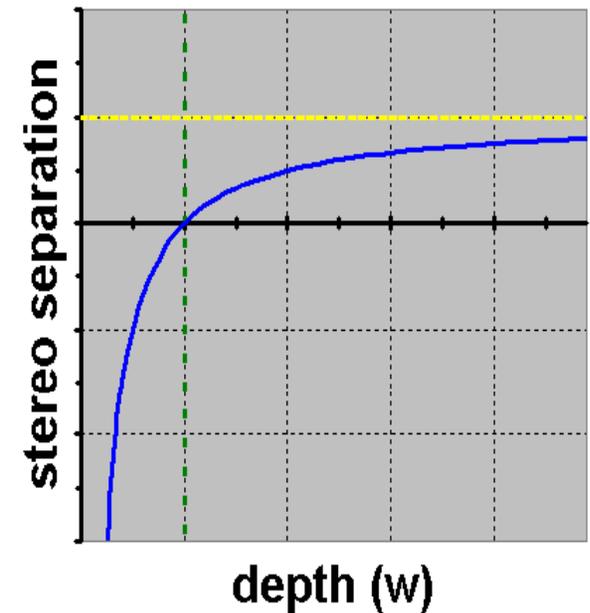
depth (w)

Maximizing stereo effect
(continued)

- Try to fit as much of your scene as possible within W range between screen_depth and screen_depth*100.
- Set screen_depth to the maximum possible value (using "convergence adjustment" hotkeys).
  - But make sure objects do not come out of the screen and get clipped by screen sides.
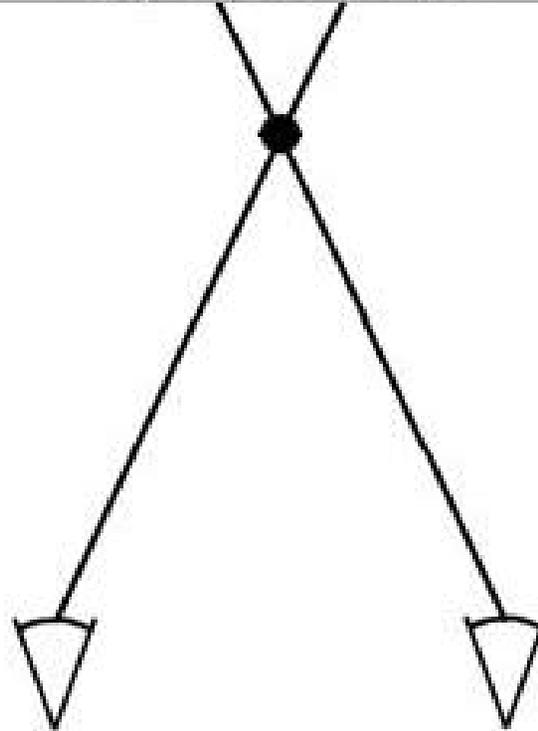
Out of the screen effects

right eye
image

left eye
image

left eye

right eye

Out of the screen effects

(continued)

- Object appears out of the screen if it has negative stereo separation (right eye image is to the left of the left eye image).

- Cannot get clipped by the sides of the screen.

Out of the screen effects
(continued)

- A mind may refuse to believe that something is hovering outsize of the screen (you will see double image), so some additional convincing may be needed:
  - Highly realistic rendering helps.
  - Move object slowly from inside the screen to the outside area to give eyes time to adapt.

Games not written for stereo are unlikely to have good out of the screen effects

- This is an opportunity to differentiate your game!
- We are looking for 3D Stereo showcase titles and NVIDIA promotions

Other issues

- Some displays support stereo only in specific resolutions, and they may not be standard. Make sure your application supports all resolutions reported by the driver.

- Some stereo output modes degrade resolution compared to the original, such as line interleaved stereo. Make sure that text is rendered using large fonts, and do not use line primitives.

Other issues (cont.)

- Most of the current stereo output devices do not have a 100% cancellation of right eye image in the left eye and vice versa. This results in "ghosting". Highly contrast scenes will be more likely to suffer from this issue.
- Polarized glasses reduce overall brightness of the scene, so monitor brightness may need to be increased for viewing in stereo mode.

How NVIDIA Can Help

- Work with our devtech engineers to get us early access to titles for 3D stereo evaluation and feedback

- Get your development environment "3D stereo ready" for on-site testing

- Game promotions/bundles

NVISION
Stereo Knowledge Sessions

- "Live Lab" with 3D stereo game LAN
- Technical sessions on 3D stereo challenges
- Panel on 3D Stereo techniques and future
- 3D Stereo 2700 seat theater for premieres
- 3D Stereo for HH devices

Thank you!

- Questions?
- Demo:
  - Visit NVIDIA or partner booths
- Discussion board:
  - forums.nvidia.com
    Hardware->3D Stereo

APPENDIX

How to Install and Enable

1. Install standard GeForce driver and reboot.

2. Install GeForce 3D Stereo driver (no reboot)

3. Go to 3D Stereo Control Panel and enable stereo. Your monitor should be automatically detected and the correct 3D stereo display type/size will be selected.

4. Run the test app, to make sure stereo works.

Configuring 3D Stereo Game Profile

- Note the current stereo mode
  - "Always on"
  - "On by hotkey," hotkey is *Ctrl-T*.

- Run the game, and enable stereo mode. It may not be correct at this point.

- Hit "Save Configuration" hotkey *Ctrl-F7*

Configuring 3D Stereo Game Profile (cont.)

- Configuration is saved to HKLM\Software\NVIDIA Corporation\Global\Stereo3D\GameConfigs\<game exe name>
  - Add DWORD entry StereoTextureEnable: 1
  - Add DWORD entry StereoCutoff: 1

- These are optimal values for games that do not render directly into backbuffer. We will likely make them default in the future.

- Try running your game again after setting these values.