Immersion: The Challenge for Commodity Gaming

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Introduction

• Sense of immersion, of “being there” is greatly enhanced when all or a significant portion of the human visual field is engaged.

• A key requirement for virtual reality is the virtual environment filling the viewers field of view, none of the real world impinges.

• Often referred to as “removing the frame”, the frame around almost all digital display devices.

• Importance accepted in commercial/military simulators. Almost universally unsupported in the gaming industry!

• Compared with stereoscopic 3D which is widely supported in the gaming industry. I claim
  1. Stereoscopy is rarely engaged with in gaming except for initial novelty
  2. It doesn’t offer a gaming advantage and has significant disadvantages
Prior user testing and motivation

• 2010: Comparison of monoscopic - stereoscopy - and immersion in a FPS.

• Players in immersive environment performed better despite slightly lower frame rates and lower resolution imagery than monoscopic and stereoscopic display.

• Peripheral vision evolved for early detection of danger.

• Players universally preferred the immersive environment.
Prior user testing and motivation

- 2010: Comparison of monoscopic - stereoscopy - immersion in a non-aggressive game.
- Used standard demo scene for Unity. Players asked to simply explore.
- Players in immersive environment reported more discoveries than in monoscopic and stereoscopic. Also travelled further, did less backtracking indicating higher environment awareness.
- Players universally preferred the immersive environment.
Multiple displays

• The high use by gamers of multiple displays would suggest they appreciate the effect and benefits.

• Noting however that multiple displays are still a long way from filling the human FOV.
Example: Liquid Galaxy

- Googles Liquid Galaxy is one exception.

- Example that generic support for a range of immersive displays is possible.

- Also illustrates the possibility of generic support for distributed (cluster based) rendering of realtime graphics.
Example: jDome

- Even doing it wrong can be compelling enough!

- The jDome simply uses very wide angle perspective camera and rear projects onto a dome.

- The imagery in the far field is greatly distorted and is not conveying the correct imagery.

- Has the advantage of using unmodified games.
Simulators

• In simulators the value of immersive displays is well established.

• Use the phrase: “Situational awareness”.
Why not?

• Why are there not products that more fully utilise the human visuals system?

• Economics? Space?

• Unlike stereoscopy there is lack of experience of immersive displays. Digital planetariums being one of the few examples.

• It is technically more challenging for developers?
Why is it difficult?

• The current hardware accelerated realtime graphics APIs only support two projections: orthographic and perspective.

• A wide field of view (> 100 degrees say) cannot be (efficiently) generated from a single perspective projection.

• In the past graphics performance for multiple pass rendering was problematic.

• Capturing/intercepting graphics calls is more complicated than the stereoscopic case.

• Multipass rendering (multiple camera frustums) is necessary.

• Views generated are user/screen position dependent. Even for the simplest three panel display the three correct frustums depend on the viewer position and the panel orientation.
Why is it difficult?

- There are potentially a wide range of display configurations. [Could buy the viewing hardware as part of the game]

- Compared to stereoscopy where the underlying technology may be different but one still creates the same stereo pairs.

- Creating custom pipeline and parameters for each display geometry would be an overwhelming burden on game developers.

- Depending on the display one needs to handle some or all of the following:
  - Image splitting
  - Geometry correction
  - Edge blending
Solution

• Separate the field of view requirements from the display geometry requirements.

• As a minimum the game needs to at least support the generation of sufficient visual information.

• Only then can hardware manufacturers have the chance of converting that to meet the specifics of the display.

... It then becomes a matter of standards, how the hardware and device specific manufacturers access the image data through a plugin mechanism, for example.
Creating sufficient image data

- All surround displays can be supported by capturing 6 perspective views.
- Many can be supported with fewer.
- Stereoscopic versions need a second set of cube views, one from each eye position.
- Once the visual field of view is captured the rest is just image processing.
- The game engine doesn’t need to concern itself with viewer position with respect to screen surfaces, that is taken care of by the image warping phase.
Example: Hemispherical dome

- Most hemispherical dome displays require 4 cube faces.
- Examples include the iDome and current digital planetariums.
Example: Hemispherical dome

Games responsibility

Display providers responsibility
Example: Tiled panels

Games responsibility

Display providers responsibility
Example: Cylindrical display

Data projector 1

Data projector 2

Data projector 3
Summary

• Immersion via peripheral vision is a key element for performance and engagement.

• Propose a solution for game engine developers who intent to support immersive displays.

• Tested / implemented to date in Unity3D, Blender, Quest3D.

• Effort is split between game engine developer and hardware supplier.
  - Game engine needs to create the imagery.
  - Hardware specific components is only image mapping.