



A Scalable End-to-End Optimized Real-Time Image-Based Rendering Framework on Graphics Hardware

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Presentation Outline

- Introduction and Previous Work
 - Application drivers and image-based rendering
 - Prior work and its limitations
 - Our research motivations and major contributions
- Framework Description
 - A layered view of the framework
 - Optimized towards the graphics hardware
 - Performance scalability
- Experimental Results
- Conclusion and Future Work

Application Drivers

Autostereoscopy enables immersive 3D experience without special binoculars.



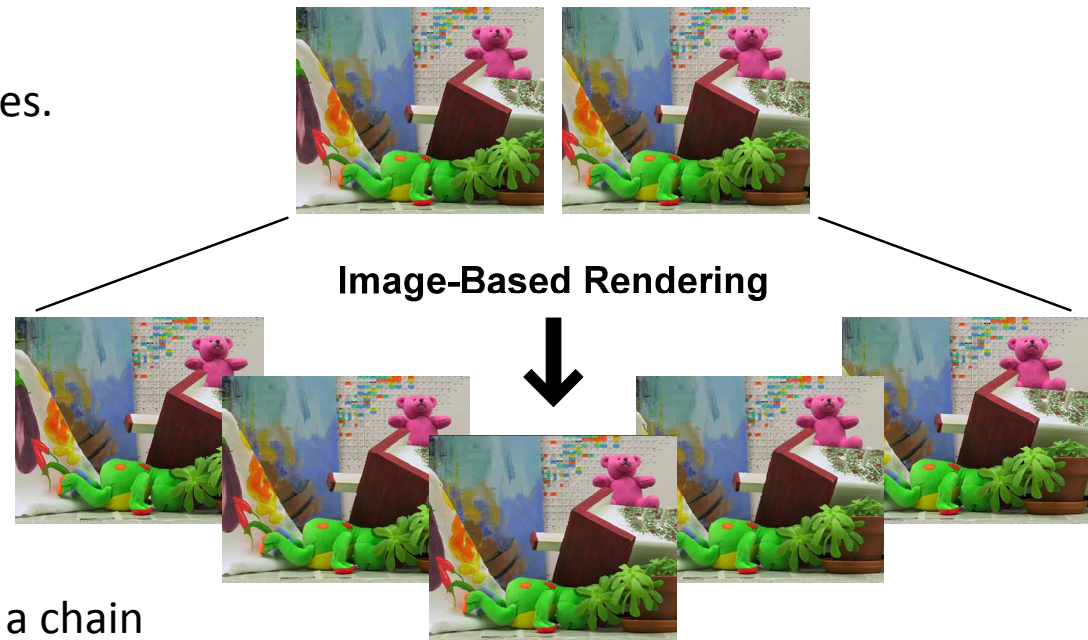
Free-view surveillance.

Sparse camera bullet time effect.

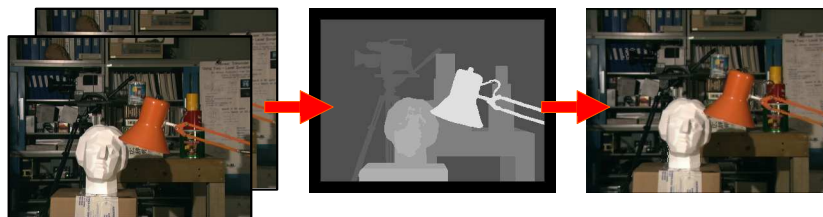


Image-Based Rendering (IBR)

IBR = Generate N intermediate views from 2 (or M) input images.



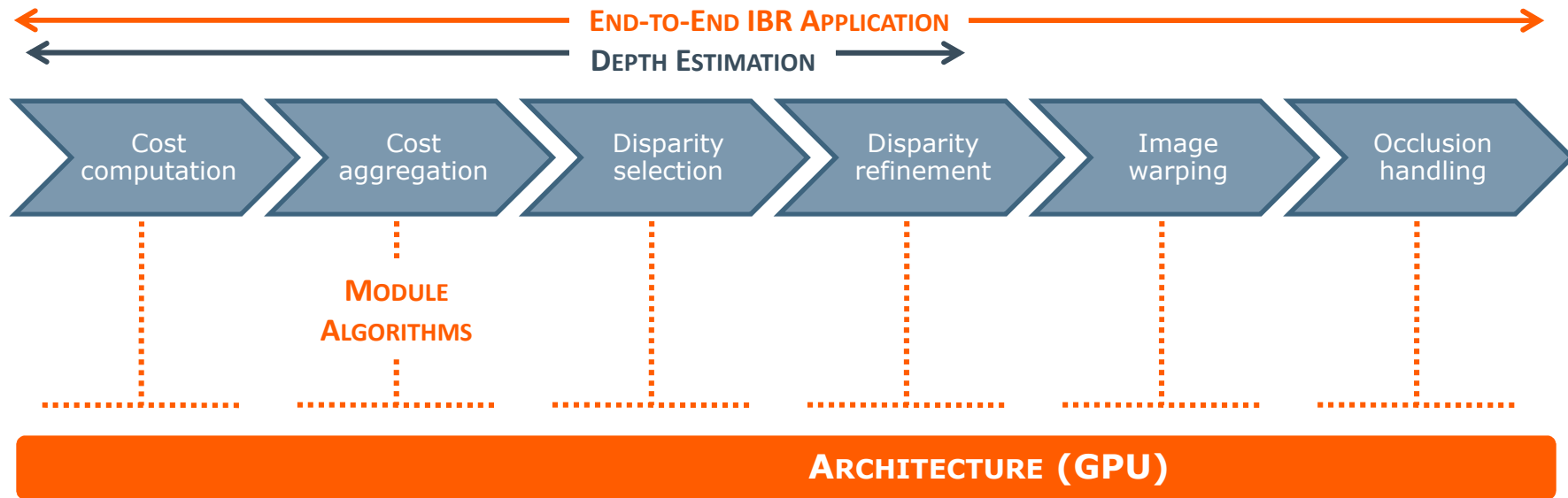
Originated from stereo → IBR is a chain of consecutive processing modules.



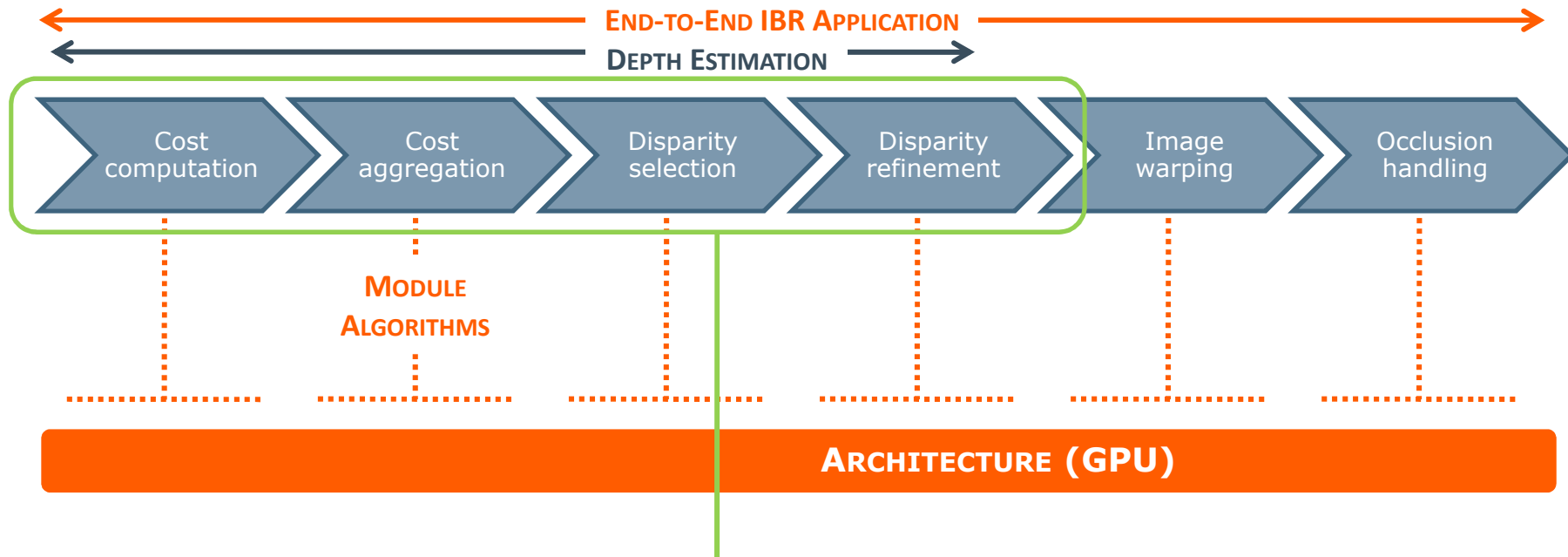
Challenging due to:

- High interpolated view quality
- Real-time requirement

Prior Work and Its Limitations



Prior Work and Its Limitations

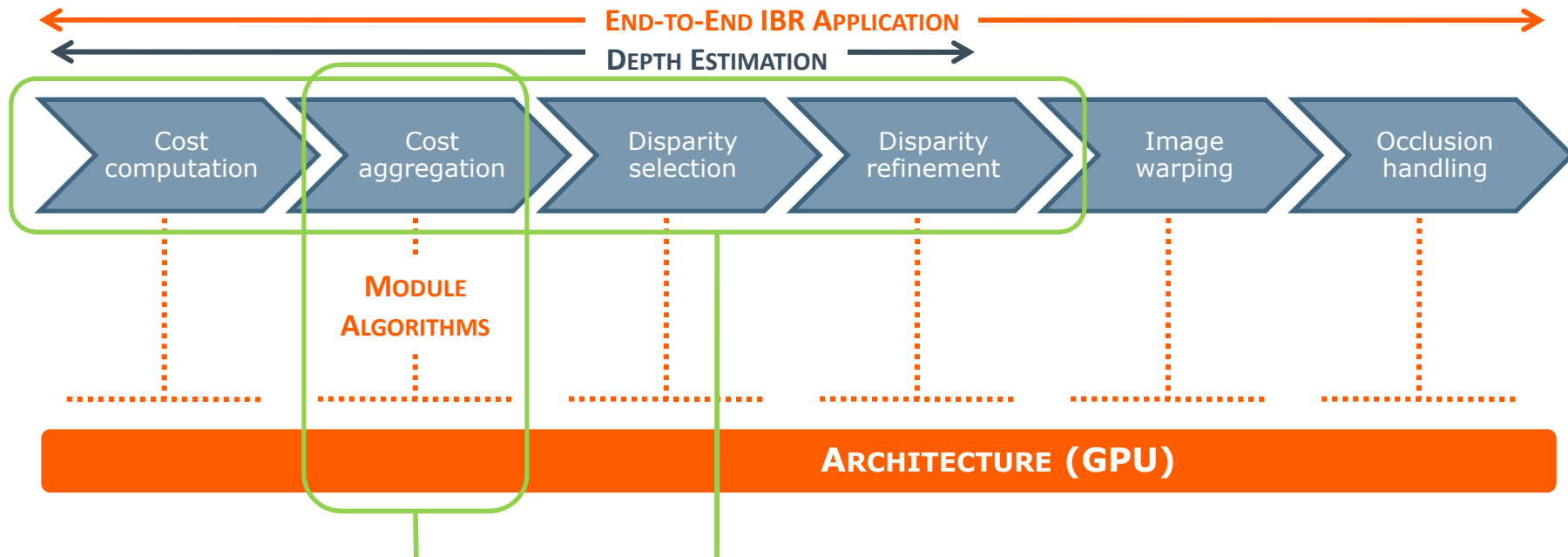


[Scharstein and Szeliski IJCV'02]:
Framework for depth evaluation.



**No interest in speed
and optimization towards
architecture!**

Prior Work and Its Limitations



[Wang et al. 3DPVT'06]:
[Gong et al. IJCV'07]:
A recent performance study for
real-time stereo on GPU.



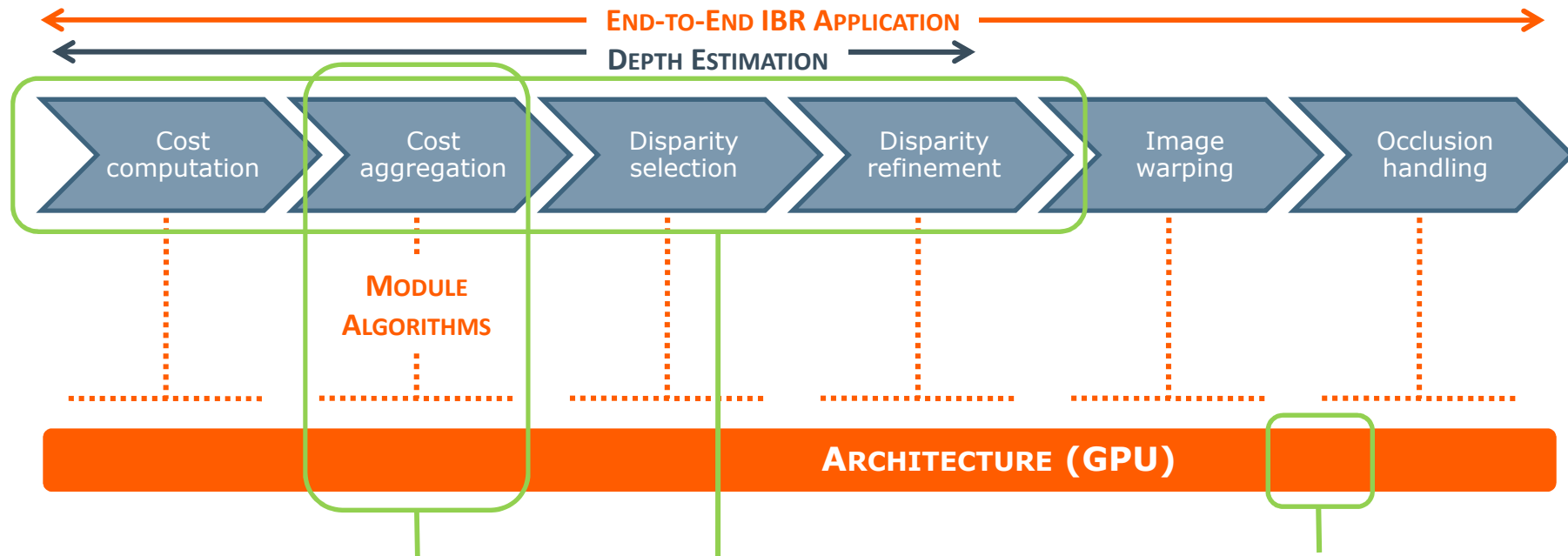
Not covering view synthesis!

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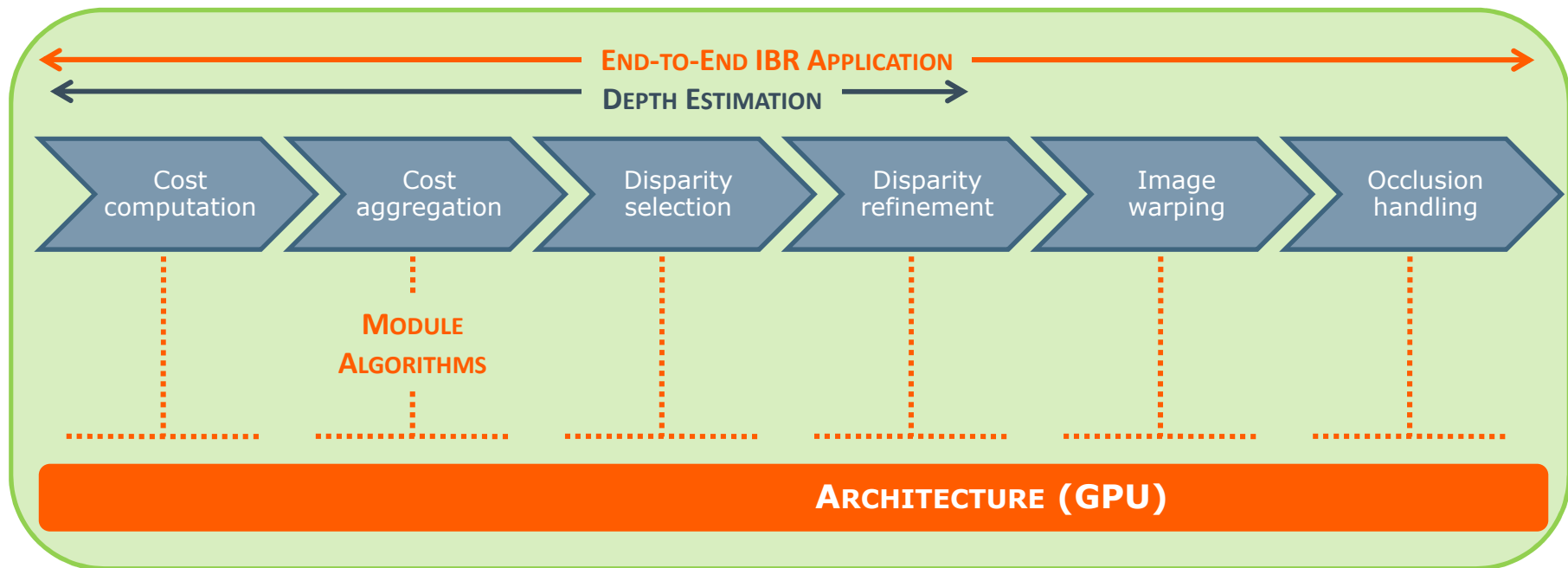
↓
No interest in speed and optimization towards architecture!

[OpenVIDIA 2002-08]:
Generic framework for vision on GPU.

↓
No modules for stereo and view synthesis.

Research Motivations and Contributions

Our major motivation: **Solve/Facilitate IBR design space exploration through a framework!**

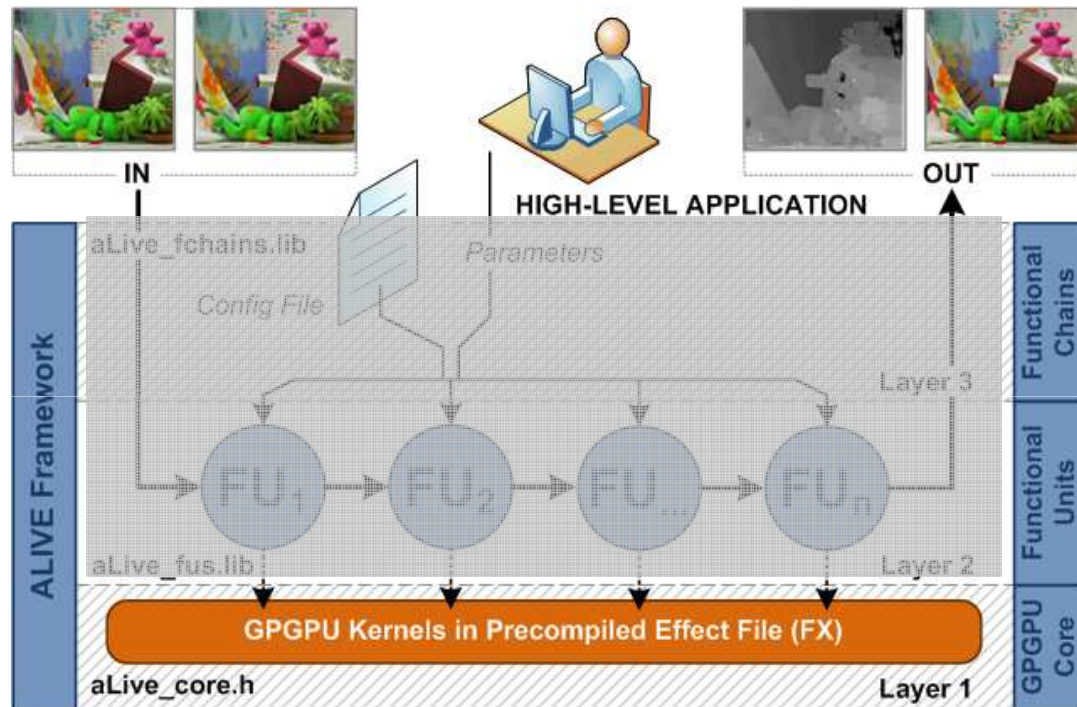


1. End-to-End: We extend the ideas of Middlebury with view synthesis modules.

2. Optimized toward GPU: We add an additional 'axis' towards architecture optimization.

3. Scalability: Framework validation by great speed increase, minimal drop in visual quality.

A Layered Overview of the Framework

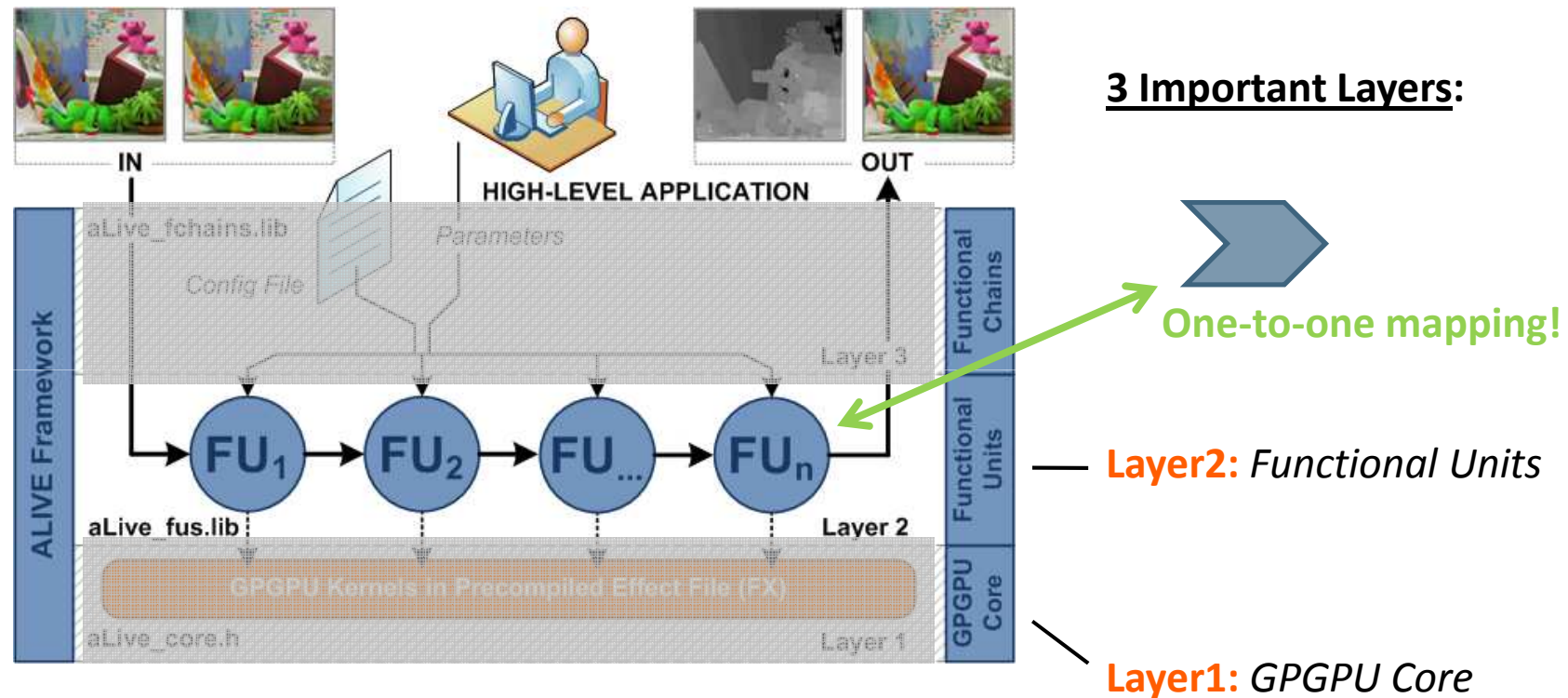


3 Important Layers:

Layer 1: GPGPU Core

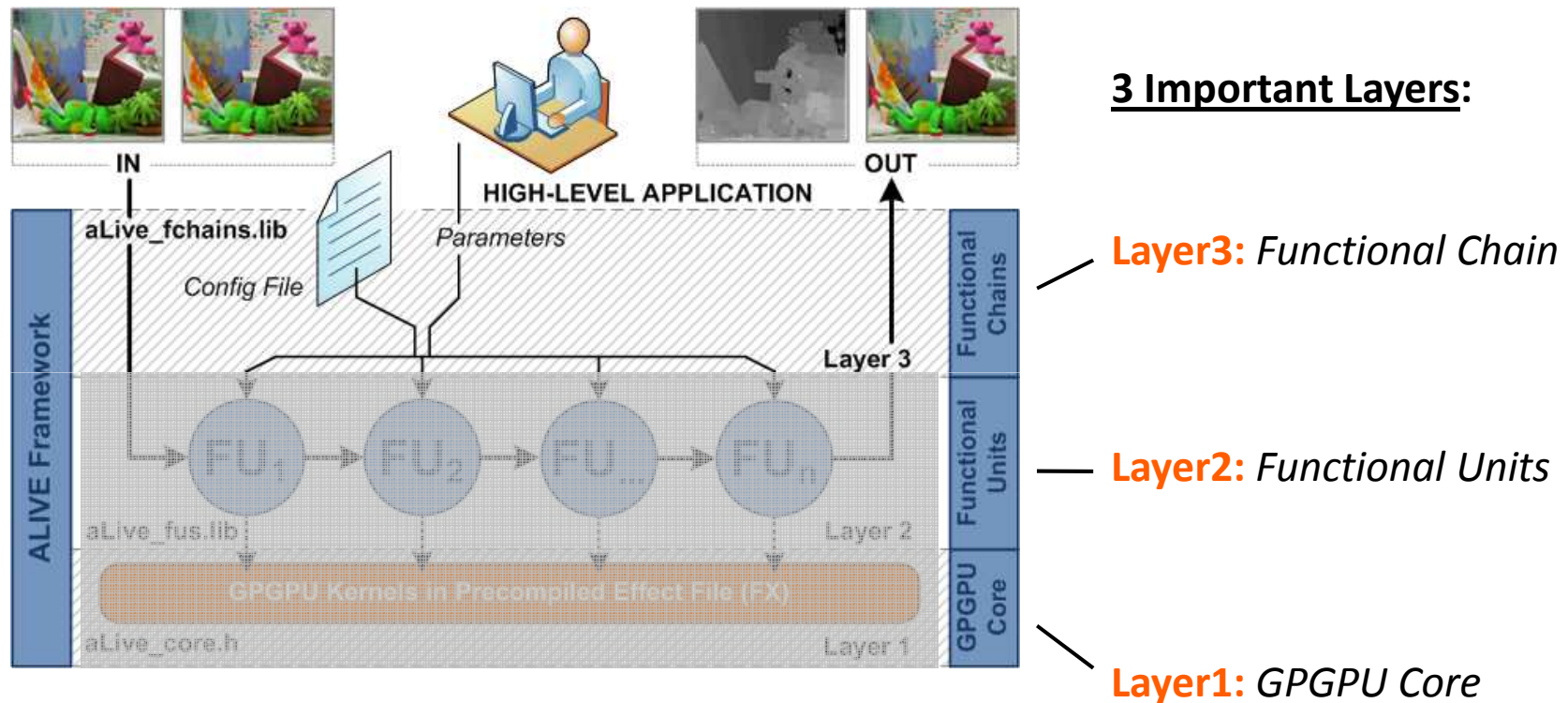
Fully optimized GPGPU kernels using optimizations to lever the utilization such as **vector packing**, kernel fusion in **MRT**, and **Early-Z** for great occlusion handling acceleration.

A Layered Overview of the Framework



Transparency is provided by using **FUs as algorithmic processing modules** that assemble all (graphical) code that is needed to invoke the kernels.

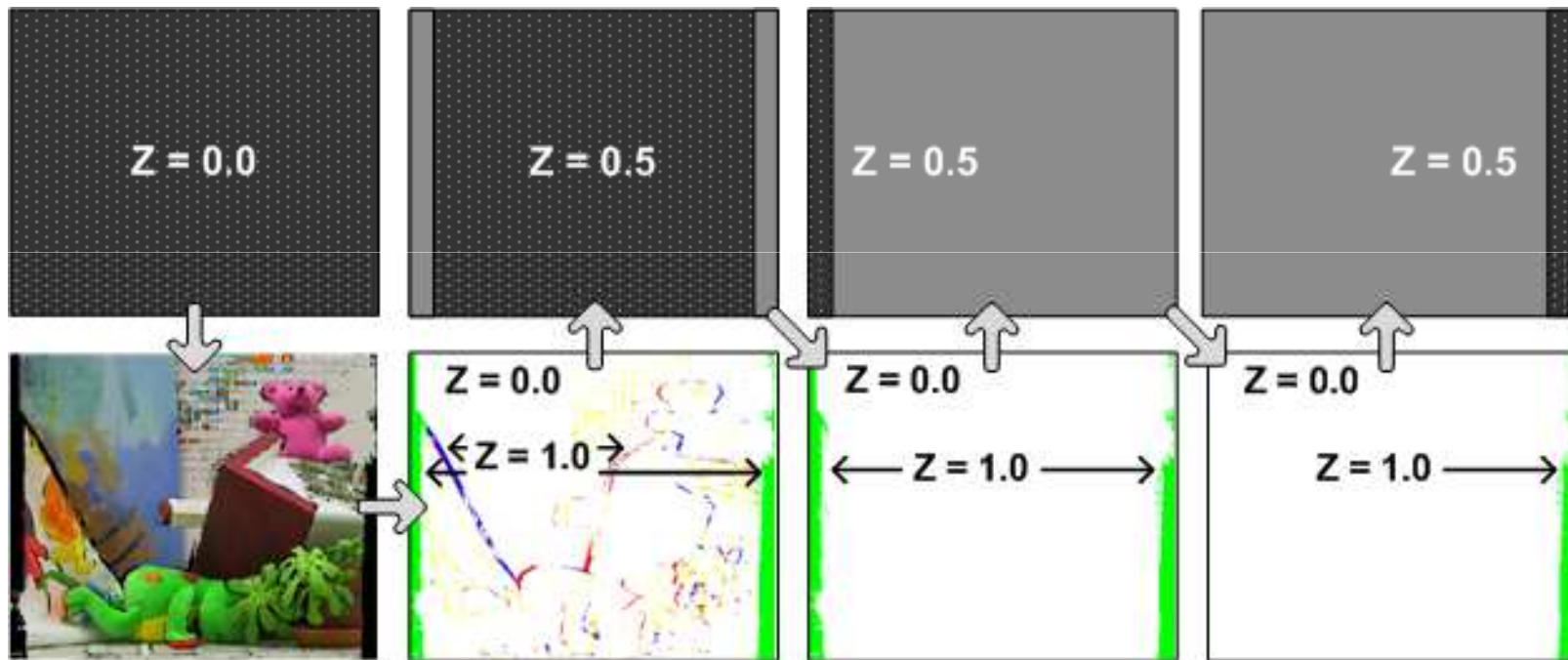
A Layered Overview of the Framework



The chain allows to **flexibly** coordinate the FUs due to the layered approach, but maintains its conformity with the **stream processing paradigm**.

Optimized Towards the Graphics Hardware

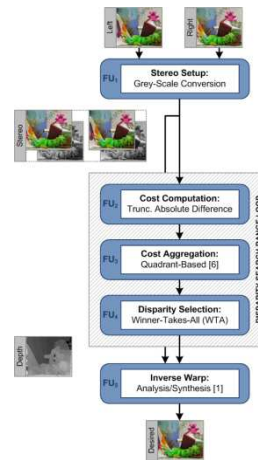
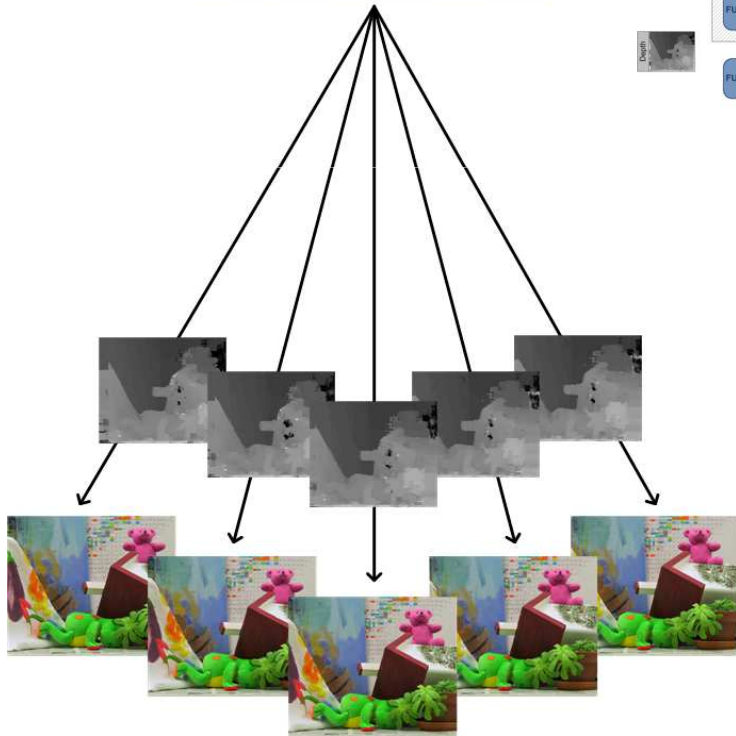
A **quick example** to demonstrate the highly optimized GPGPU kernels, exploiting the Early-Z mechanism. **This is just one of the many optimizations.**



Our philosophy: **Platform-aware algorithmic redesign** or **'Triple A'** !

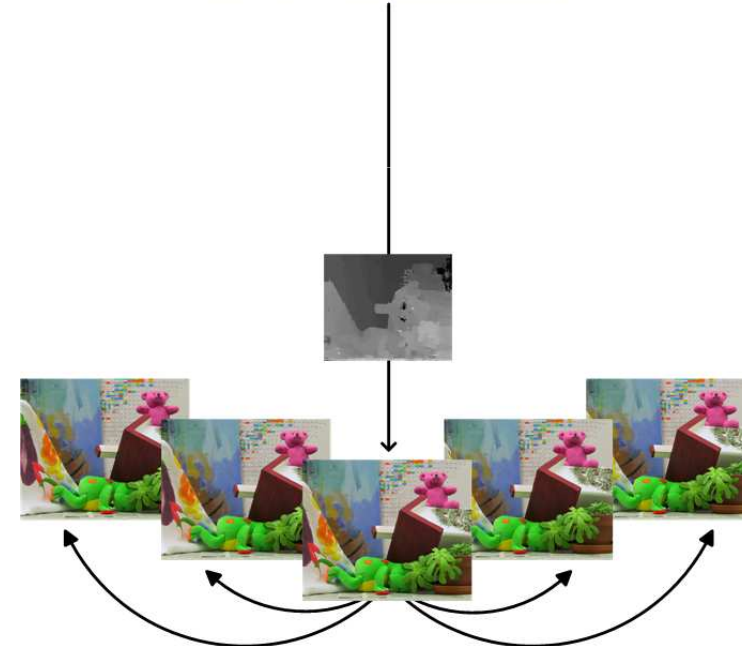
Performance Scalability

'Inverse Warping' High-Quality Mode



VS

'Forward Warping' Fast Mode



Experimental Results

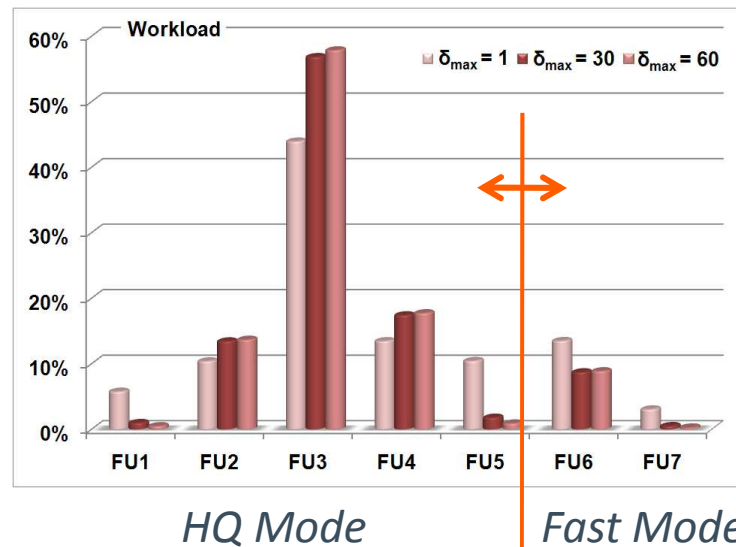
Experimental Scene Details: Teddy (Middlebury), 475x350 pixels, disparity range 60.

GeForce7900 GTX (Original test GPU): over **44 fps** and **400 Mde/s**.

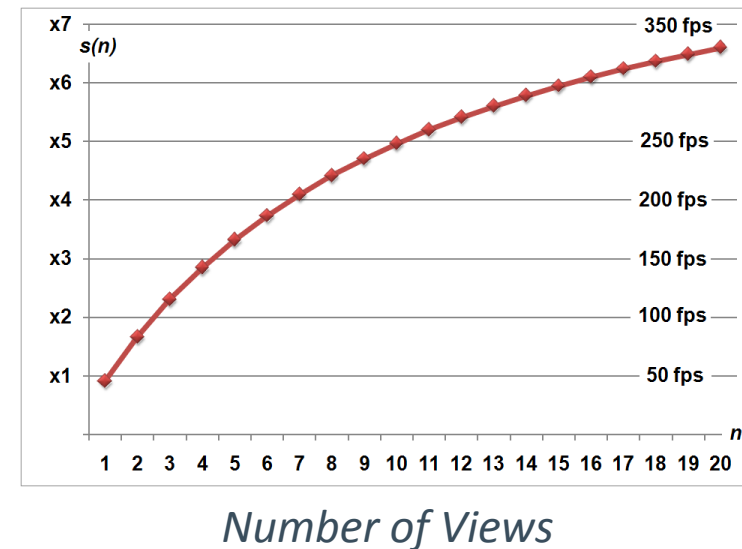
GeForce 8800 GT (Mainstream desktop GPU): over **110 fps** and **1Gde/s!**

Quadro FX 1600M (Notebook GPU): over **14 fps** and over **125 Mde/s**.

Quality result over **31.4 dB PSNR**.

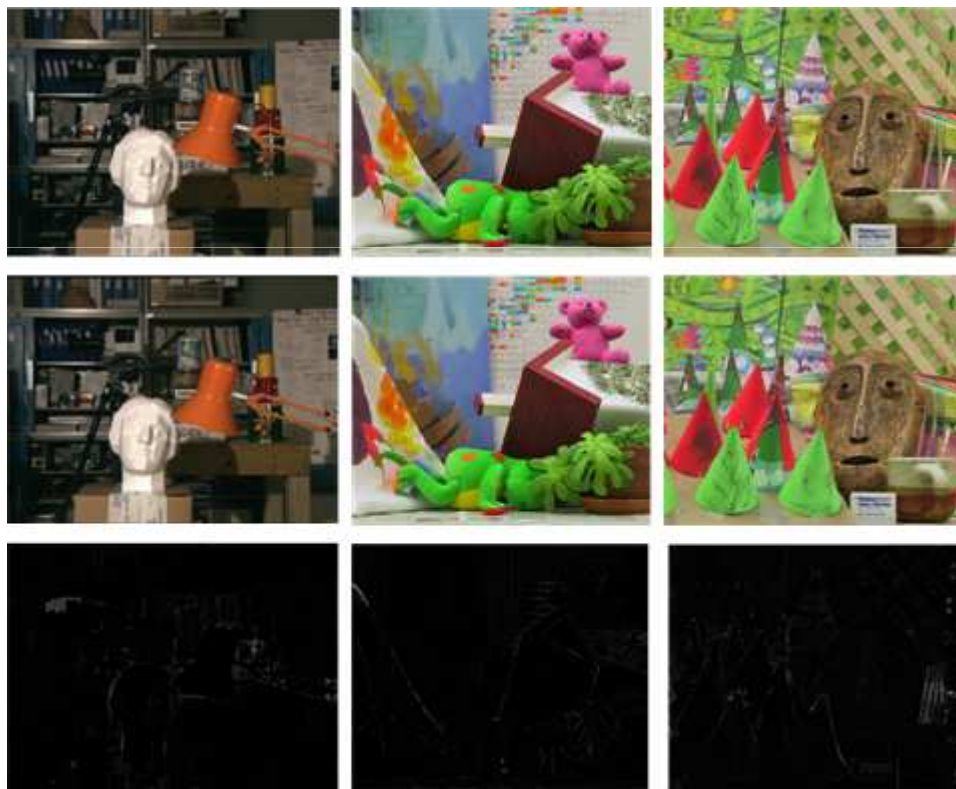


Relative Speedup



Experimental Results

Quality results: Absolute difference images and the scalability results on the Venus scene.



Conclusion and Future Work

Conclusion:

The first ever (fully GPU) framework to facilitate design space exploration for IBR to identify optimal trade-off points between the required quality and processing speed!

Future Work:

- Enable scalability in the single view synthesis.
- Implement a representative set of algorithms and benchmark this set with regards to end-to-end optimization to extract generic compatibility rules.
- Open up the framework to the broad (academic) audience.

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Lu Jiangbo and Gauthier Lafruit for synergetic collaboration, IWT for funding my PhD and IMEC/EDM for providing the research environment.

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