Foveated Refocusing For VR

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Motivation

The goal of this project is to realize the benefits of foveated rendering without imposing strict latency requirements on our image pipeline. This is important to enable wireless VR and predictive rendering techniques where everything the user will look at in the next few hundreds of milliseconds has already been rendered and buffered in the HMD. Our pipeline renders the entire image in low quality and then upscales only the foveal region in the HMD using meta data provided by the PC.

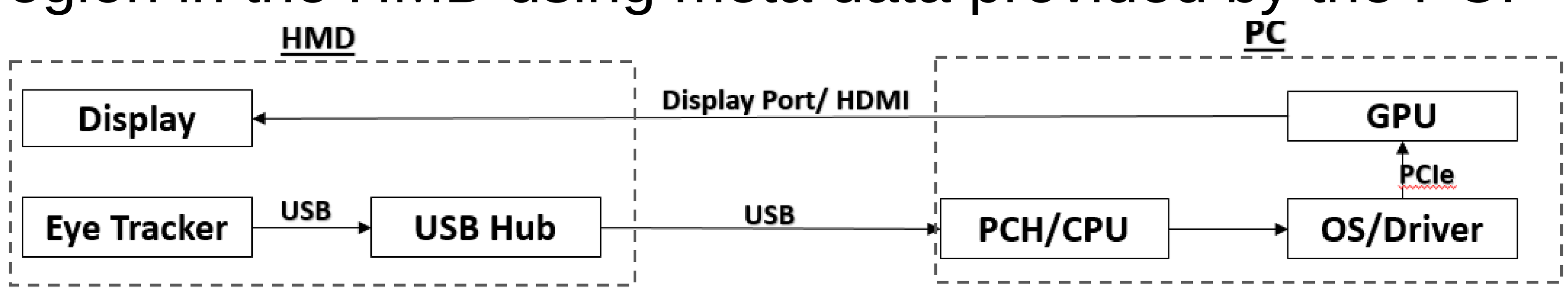


Figure1: Data Path for traditional foveated rendering

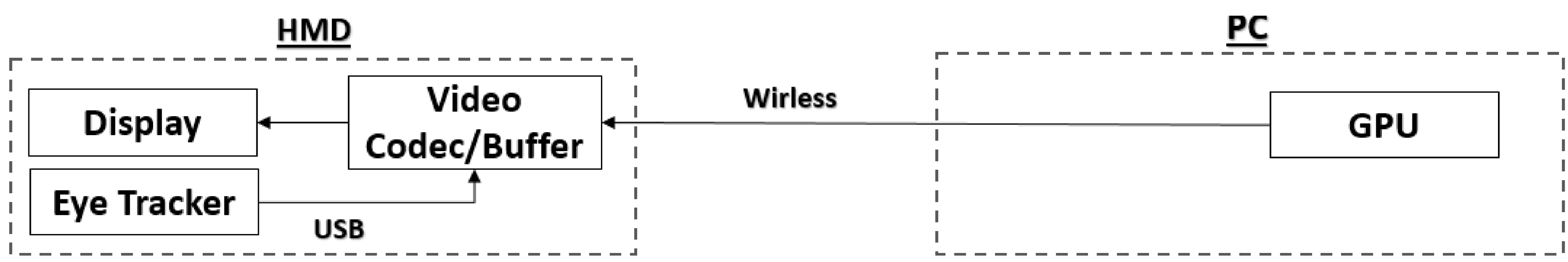


Figure2: Our proposed data path topology

Related Work

Our project builds on 3 main concepts; non-blind image deconvolution, image compression, and foveated rendering. All of these individual concepts have been thoroughly researched and explored but as far as we are aware there are none that combine all three. Achieving optimal results requires each step to be designed with other steps in mind.

References

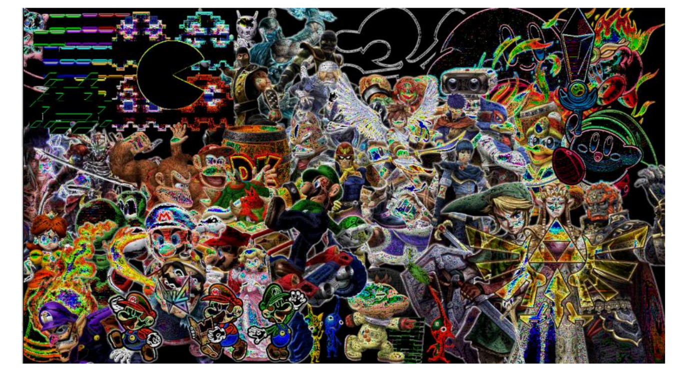
[1] S. H. Chan, X. Wang and O. A. Elgendy, "Plug-and-Play ADMM for image restoration: Fixed point convergence and applications," IEEE Transactions on Computational Imaging, Nov. 2016.

[2] Ruxin Wang, and Tao Dacheng . "Recent progress in image deblurring." *arXiv preprint arXiv:1409.6838* (2014). Available: https://arxiv.org/pdf/1409.6838.pdf [March 9, 2018]

[3] Brian Guenter & Mark Finch & Steven Drucker & Desney Tan,& John Snyder. "Foveated 3D Graphics. ACM Transactions on Graphics (TOG)." *31. 10.1145/2366145.2366183.* Available: https://www.microsoft.com/en-us/research/wp-content/uploads/2012/11/foveated_final15.pdf [March 9, 2018]

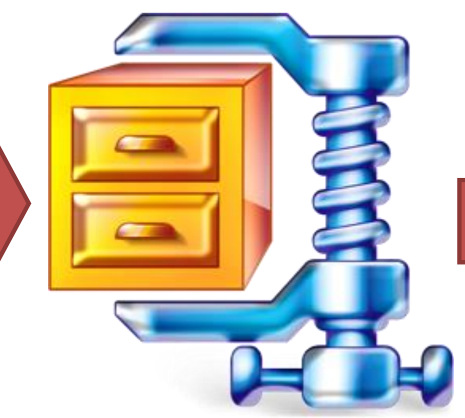
[4] Anjul Patney & Marco Salvi & Joohwan Kim & Anton Kaplanyan & Chris Wyman & Nir Benty & David Luebke & Aaron Lefohn. "Towards foveated rendering for gaze-tracked virtual reality." *ACM Transactions on Graphics.* 35. 1-12. 10.1145/2980179.2980246. Available: http://cwyman.org/papers/siga16_gazeTrackedFoveatedRendering.pdf [March 9, 2018]

Real-time Implementation Using Wiener Deconvolution



Partially render the image.

Blur the entire image. Fill missing pixels with neighboring values.



Lossless Compression

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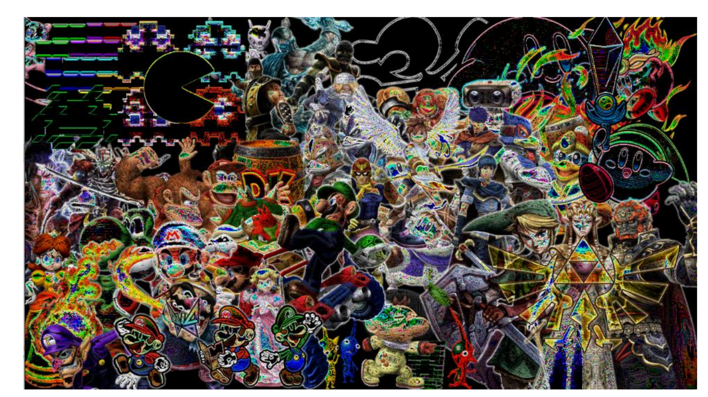
Refocus using wiener deconvolution.

ADMM Deconvolution

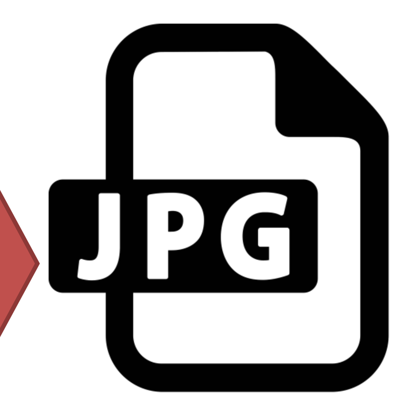


Partially render the image.

Blur the image using depth map.

Compute image gradiant.

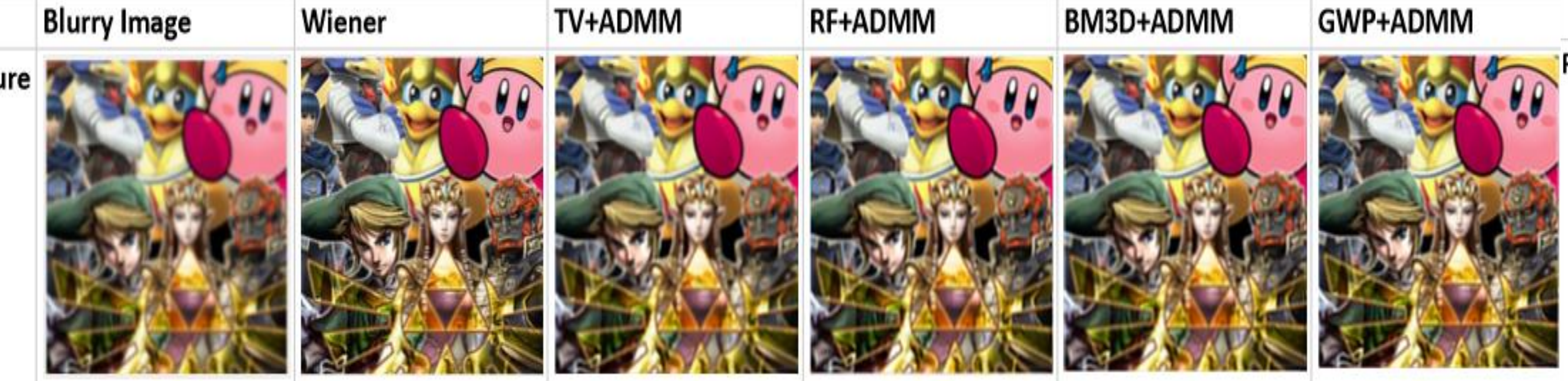
Lossless Compression.

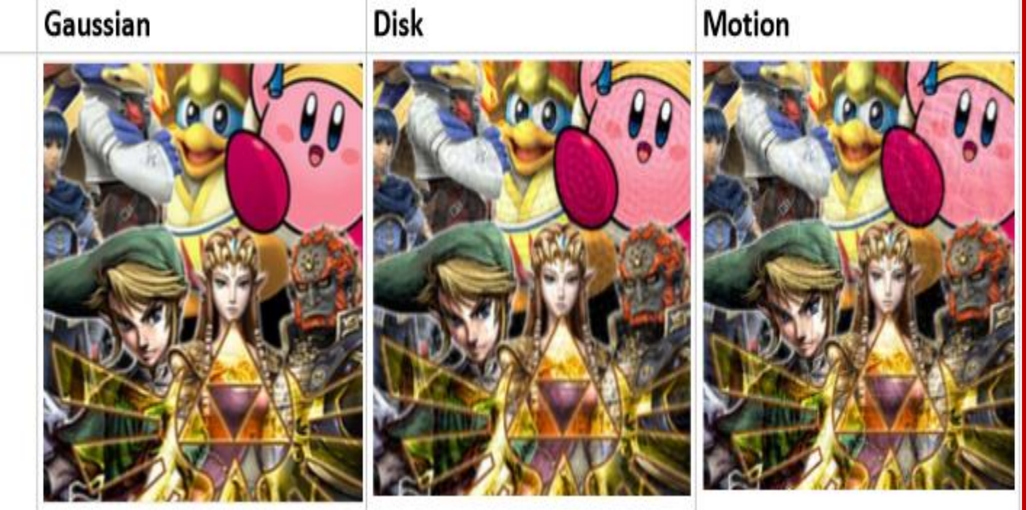


Lossy Compression.

Refocus using ADMM with gradient as prior with image having depth dependent blurring.

Experimental Results

	Blurry Image	Wiener	TV+ADMM	RF+ADMM	BM3D+ADMM	GWP+ADMM
Picture						
Time		1.24 seconds	27.71 seconds	8.17 seconds	120.3 seconds	65 seconds
PSNR		24.10db	18.19db	18.20db	18.29db	18.29db

	Gaussian	Disk	Motion
Picture			
Compression	70%	65%	79%
PSNR	25.10db	25.63db	25.47db