Euclidean Distance Transform Soft Shadow Mapping

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Agenda

- Introduction;
- Euclidean Distance Transform Soft Shadow Mapping;
- Results and Discussion;
- Conclusion and Future Work;

Introduction

Context

No Shadow

Low Computational Cost

Accurate Shadow

High Computational Cost

Shadow Mapping

Shadow Map Texture

Shadow Mapping

Accurate Shadow

Hard Shadow

Current Scenario

PCSS [Fernando2005] MSSM [Peters2016] EDTSSM

[Fernando2005] – R. Fernando. “Percentage-Closer Soft Shadows”. Proceedings of the ACM SIGGRAPH Sketches, 2005.

[Peters2016] – C. Peters et al. “Beyond Hard Shadows: Moment Shadow Maps for Single Scattering, Soft Shadows and Translucent Occluders”. Proceedings of the ACM I3D, 2016.

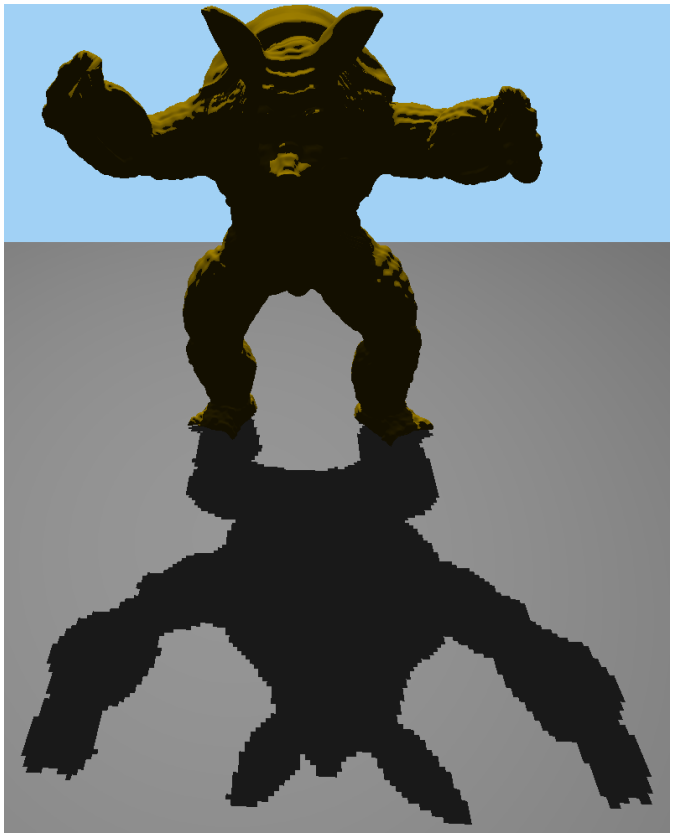
Euclidean Distance Transform Soft Shadow Mapping

Algorithm

- Step 1 - Shadow Map Rendering:

Algorithm

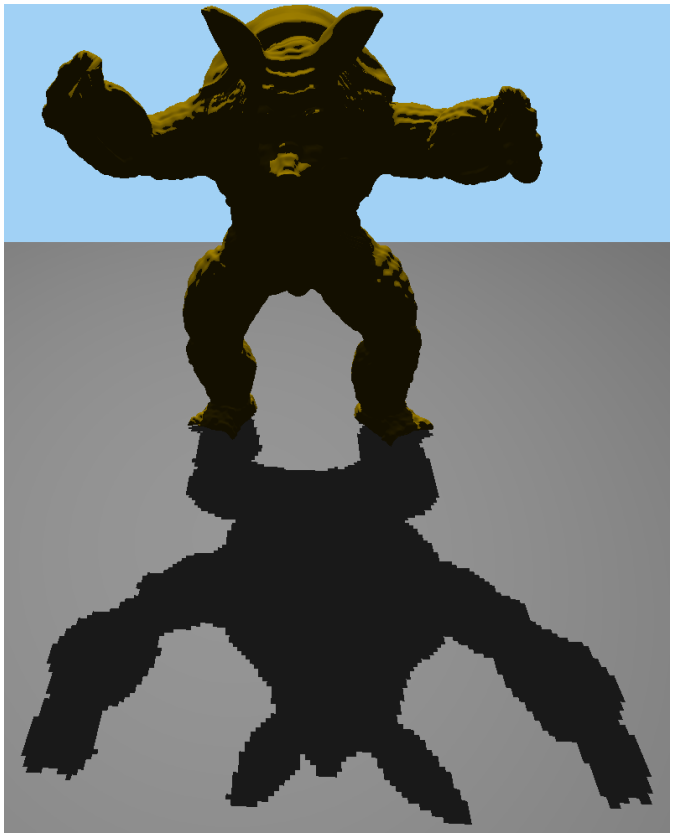
- Step 2 - Shadow Mapping [Williams1978]:

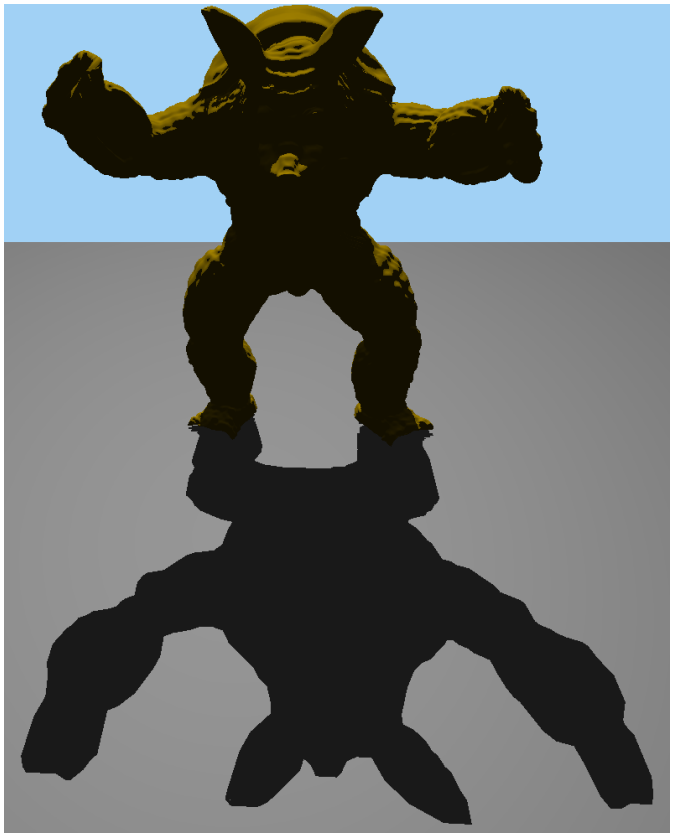


[Williams1978] – L. Williams. “Casting Curved Shadows on Curved Surfaces”. Proceedings of the SIGGRAPH, 1978.

Algorithm

- Step 3 - Shadow Revectorization [Macedo2016]:

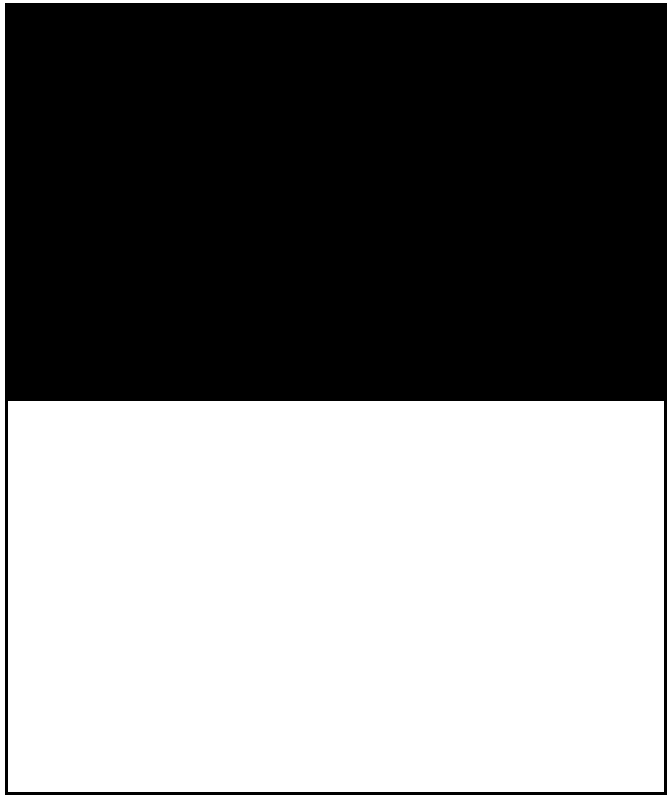




[Macedo2016] – M. Macedo, A. Apolinário. “Revectorization-Based Shadow Mapping”. Proceedings of Graphics Interface, 2016.

Algorithm

- Step 4 – EDT Soft Shadowing:



Algorithm

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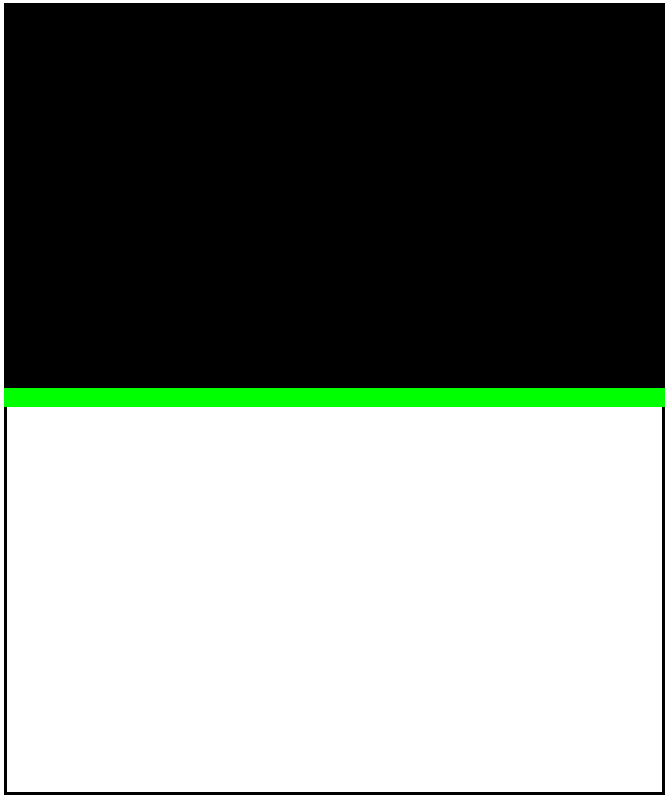

Algorithm

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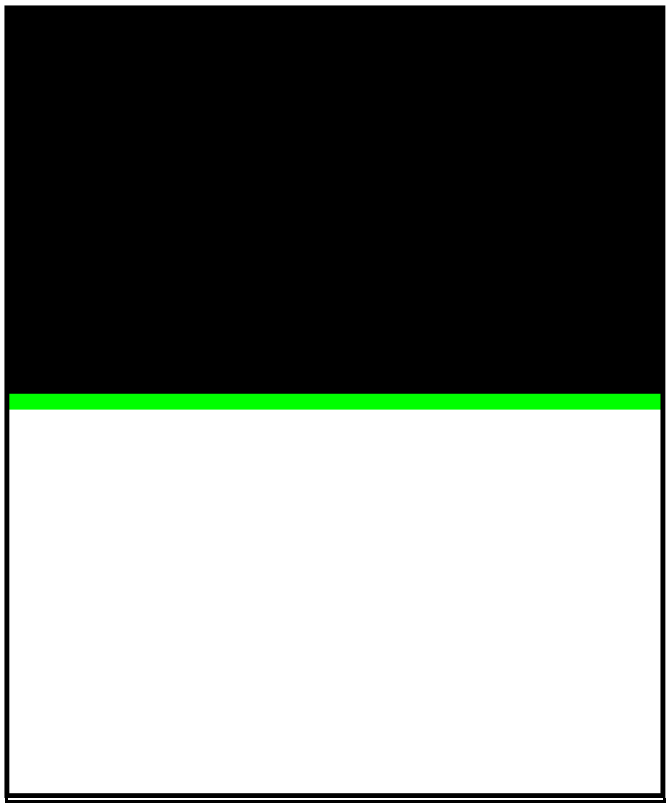
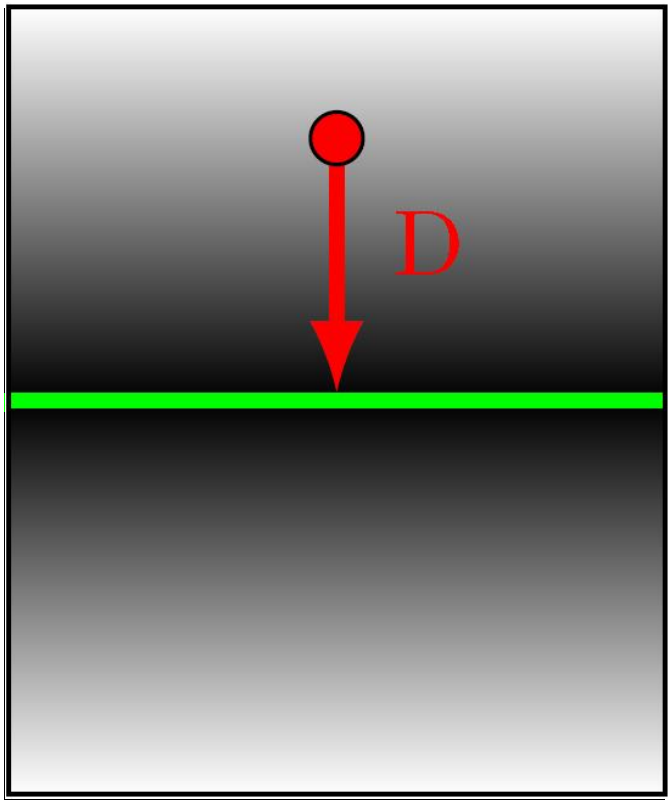


$$P = \frac{(z_{rcv} - z_{occl}) \cdot L}{z_{occl}}$$

Algorithm

- Step 4 – EDT Soft Shadowing:



Algorithm

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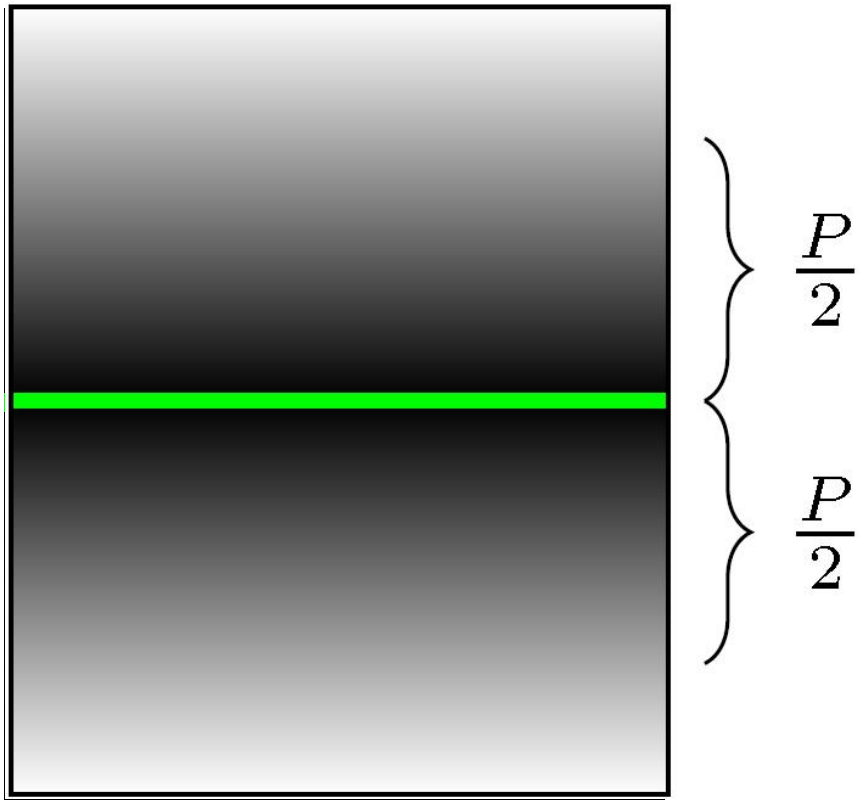

Algorithm

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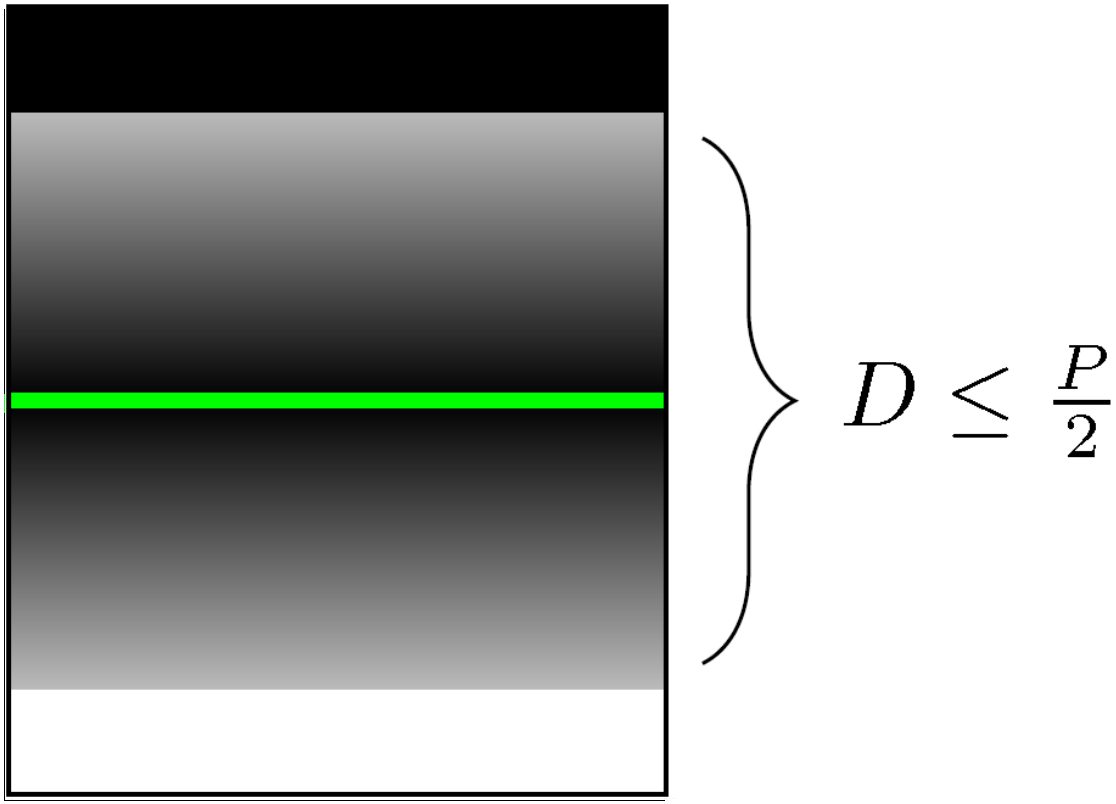
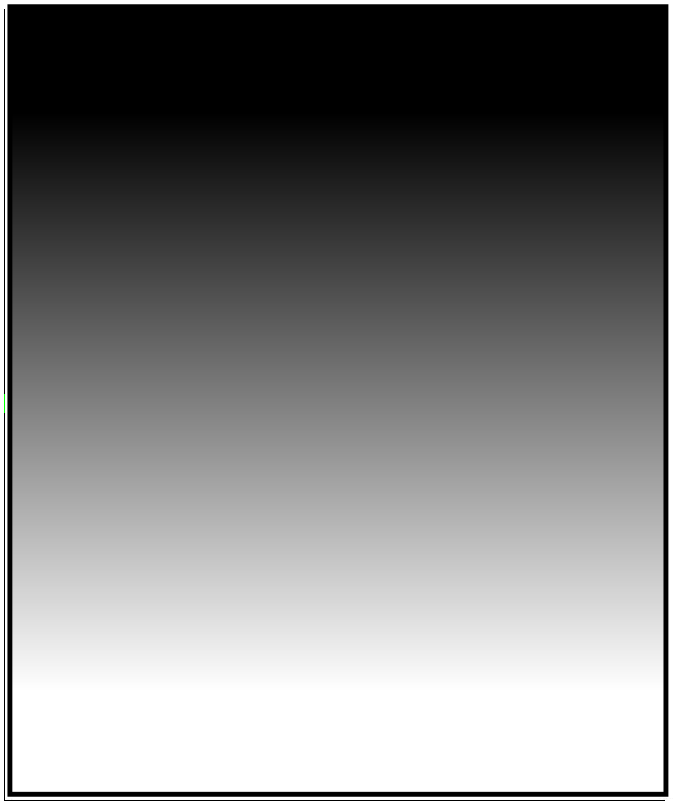


Algorithm

- Step 4 – EDT Soft Shadowing:

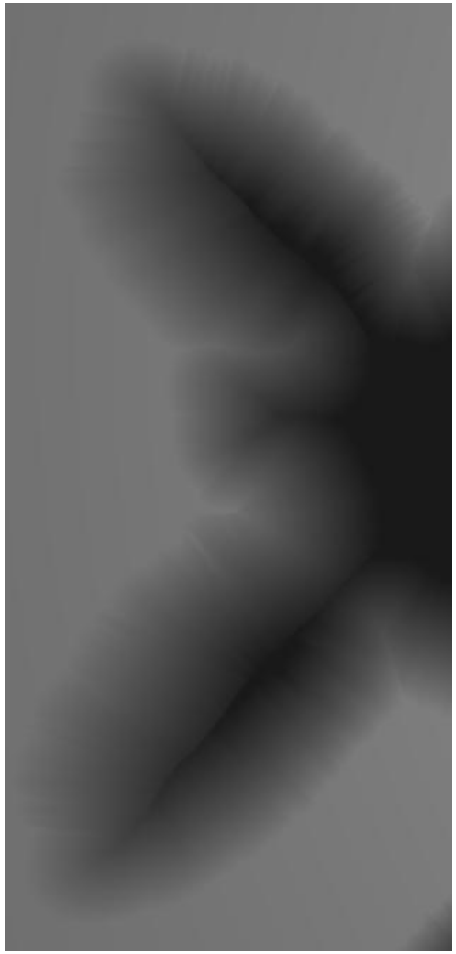


$$D = \frac{1}{2} + \frac{D}{P}$$

$$D = \frac{1}{2} - \frac{D}{P}$$

Algorithm

- Step 5 – EDT Filtering:



Algorithm

- Step 5 – EDT Filtering:

Results and Discussion

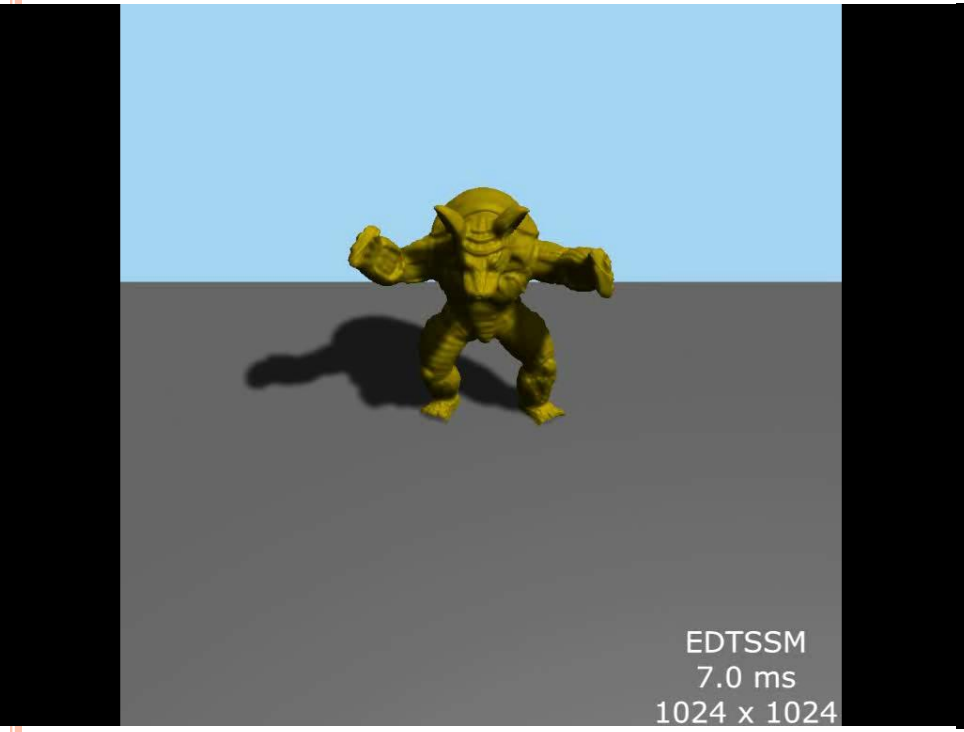
Experimental Setup

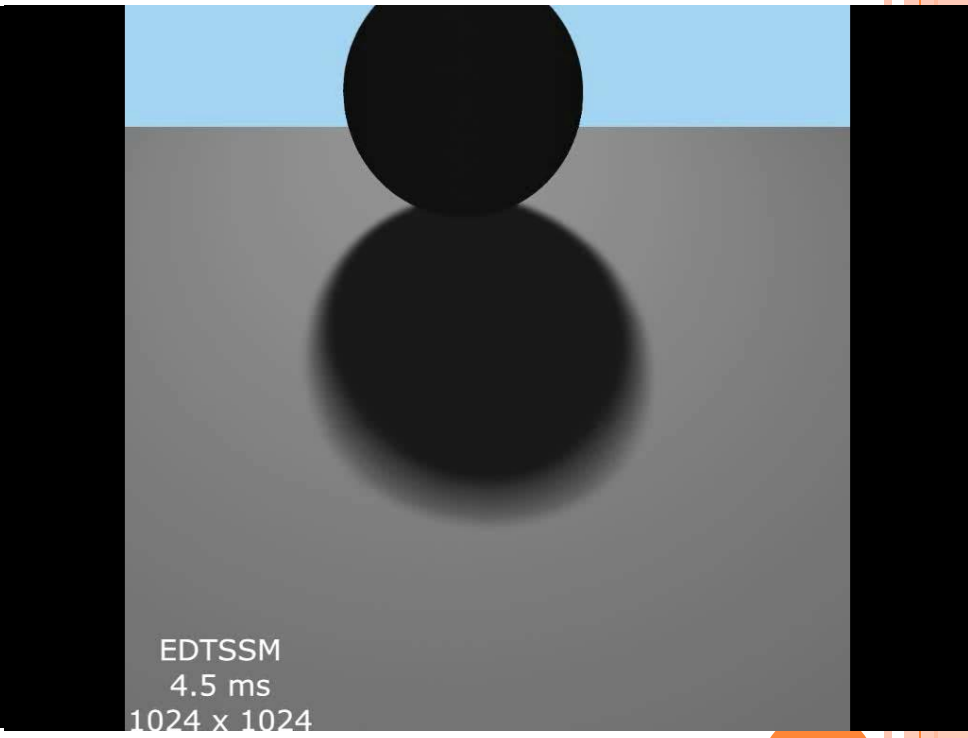
- For all tests, we used an Intel® Core™ i7-3770K CPU @3.50Ghz, 8GB RAM, NVIDIA GeForce GTX Titan X;
- EDTSSM (our approach) was implemented using OpenGL and GLSL languages;
- To compute the EDT, we have used the PBA algorithm [Cao2010] implemented in CUDA;
- A kernel size of 15 x 15 was used to suppress skeleton artifacts for our technique and banding artifacts for related work;

[Cao2010] – T.-T. Cao, K. Tang, A. Mohamed, and T.-S. Tan. "Parallel Banding Algorithm to Compute Exact Distance Transform with the GPU". Proceedings of the I3D, 2010.

Visual Quality

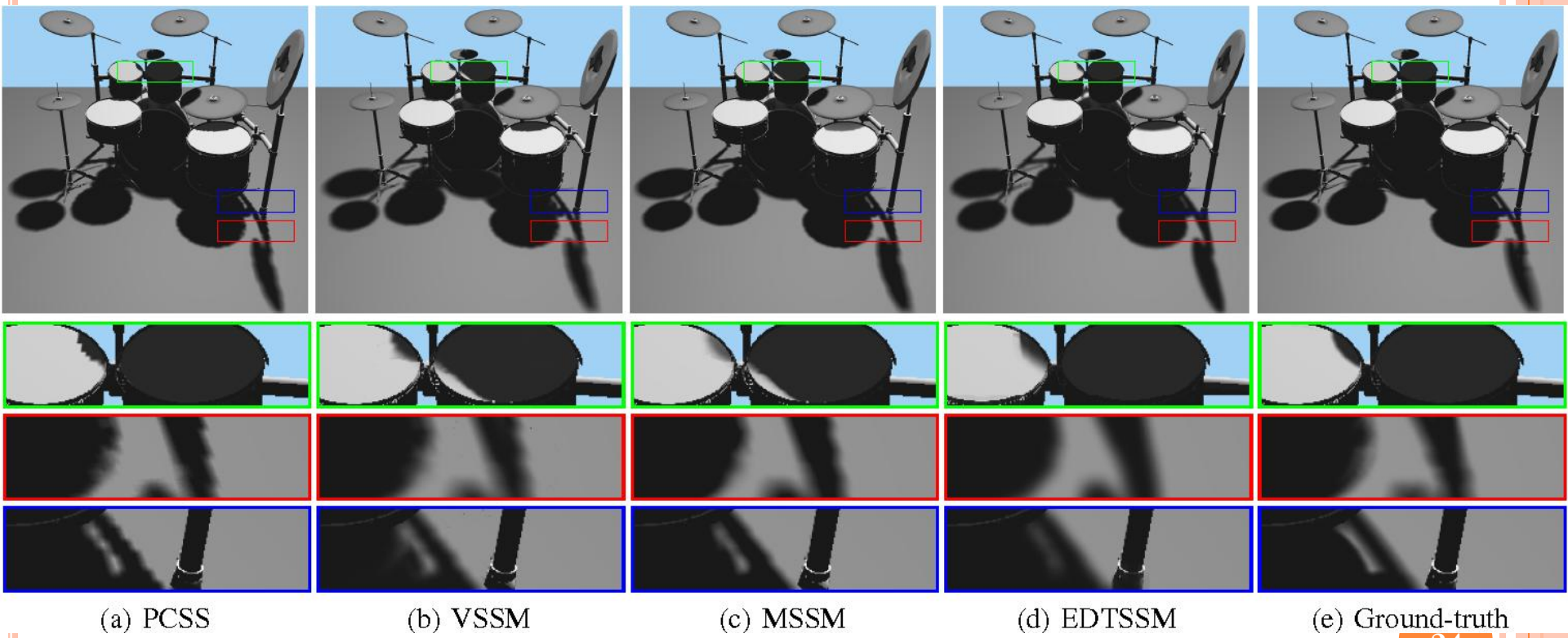
- Temporal Coherence:





Visual Quality

- Comparison with related work:



(a) PCSS (b) VSSM (c) MSSM (d) EDTSSM (e) Ground-truth

PCSS – "Percentage-Closer Soft Shadows", ACM SIGGRAPH Sketches, 2005;

VSSM – B. Yang et al. "Variance Soft Shadow Mapping". Computer Graphics Forum, 2010.

MSSM – C. Peters et al. "Beyond Hard Shadows: Moment Shadow Maps for Single Scattering, Soft Shadows and Translucent Occluders". Proceedings of the ACM I3D, 2016.

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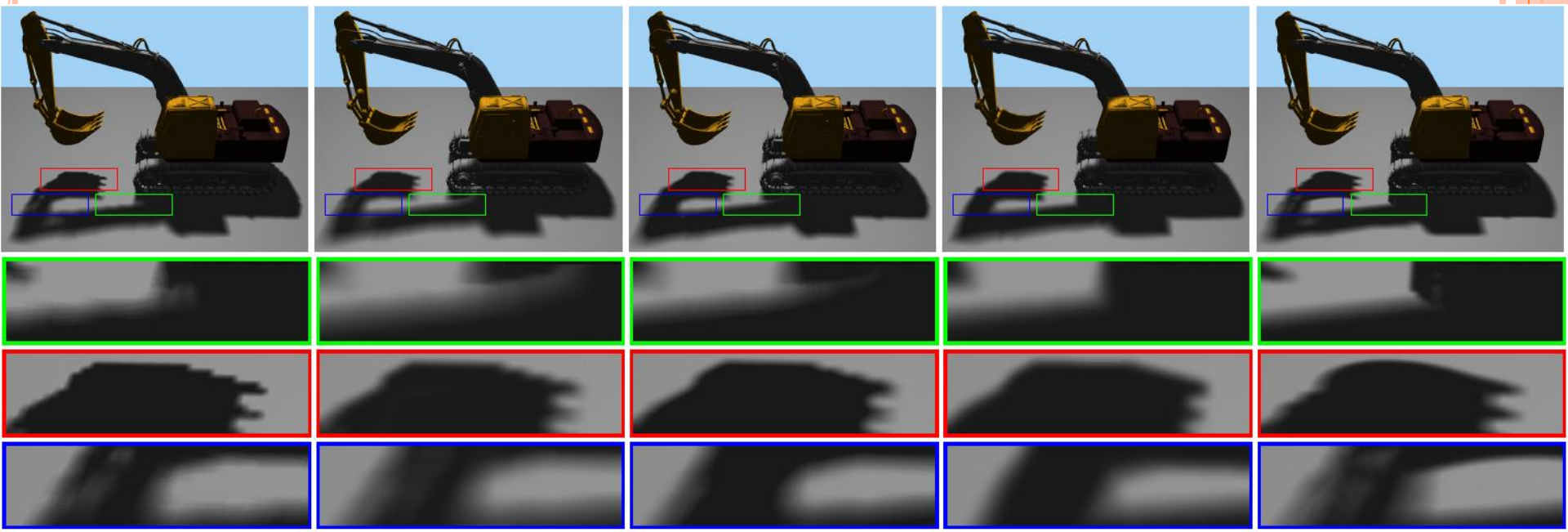

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Rendering Time

- Shadow Map Resolution:

Scene	Method	Shadow Map Resolution 512^2	1024^2	2048^2	4096^2
1	PCSS	2.8 ms	2.9 ms	3.0 ms	3.1 ms
	VSSM	2.0 ms	4.0 ms	6.5 ms	8.2 ms
	MSSM	1.8 ms	3.6 ms	5.1 ms	6.5 ms
	EDTSSM	4.3 ms	4.5 ms	4.6 ms	5.0 ms
2	PCSS	3.4 ms	3.5 ms	3.8 ms	4.0 ms
	VSSM	2.7 ms	4.6 ms	6.4 ms	8.2 ms
	MSSM	2.4 ms	4.1 ms	5.5 ms	7.0 ms
	EDTSSM	5.5 ms	5.6 ms	5.7 ms	6.1 ms
3	PCSS	4.8 ms	4.9 ms	5.0 ms	5.6 ms
	VSSM	4.7 ms	6.2 ms	7.0 ms	9.1 ms
	MSSM	4.2 ms	5.7 ms	6.5 ms	8.2 ms
	EDTSSM	6.7 ms	6.8 ms	7.0 ms	7.2 ms

Rendering Time

- Viewport/Output Resolution:

		Viewport Resolution		
Scene	**Method**	$480p$	$720p$	$1080p$
1	PCSS	1.4 ms	2.9 ms	3.1 ms
	VSSM	3.8 ms	4.0 ms	4.3 ms
	MSSM	3.2 ms	3.6 ms	4.0 ms
	EDTSSM	2.3 ms	4.5 ms	5.9 ms
2	PCSS	2.1 ms	3.5 ms	4.2 ms
	VSSM	4.3 ms	4.6 ms	5.0 ms
	MSSM	3.7 ms	4.1 ms	4.4 ms
	EDTSSM	3.0 ms	5.6 ms	6.5 ms
3	PCSS	3.8 ms	4.9 ms	5.3 ms
	VSSM	5.8 ms	6.2 ms	6.6 ms
	MSSM	5.3 ms	5.7 ms	6.0 ms
	EDTSSM	4.5 ms	6.8 ms	8.4 ms

Conclusion and Future Work

Final Considerations

- Conclusion:
  - Our technique suffers from less aliasing and light leaking artifacts than related work;
  - Our technique provides performance comparable with related work for the same scene configuration;
- Future Work:
  - Minimize shadow overestimation;
  - Speed up the EDT computation;

Acknowledgments

- We are grateful to:
  - The authors of [Cao2010] - for sharing the source code for GPU-Based Euclidean Distance Transform computation;
  - NVIDIA Corporation – for providing the NVIDIA GeForce GTX Titan X through the GPU Education Center program;
  - CAPES – for financial support;

[Cao2010] – T.-T. Cao, K. Tang, A. Mohamed, and T.-S. Tan. "Parallel Banding Algorithm to Compute Exact Distance Transform with the GPU". Proceedings of the I3D, 2010.

Thank You!

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