

# Differential Rendering of Chess



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# The Project

We had two primary aims:

- Model and render synthetic chess pieces seamlessly into a real life photograph.
- Animate a sequence of moves for the synthetic pieces.

At a glance, the synthetic pieces should be indistinguishable from the real pieces.

- Identical shape and size.
- Light reflections and shadow casting.

# The Project

## Methods and Tools:

- Physically Based Rendering framework (PBRT) by Matt Parr and Wenzel Jakob.
- Differential Rendering by Paul Debevec.
- Maya / scripting.
- Light probe image for IBL.



# Light probe image

To store incident light from distant scene into local scene.

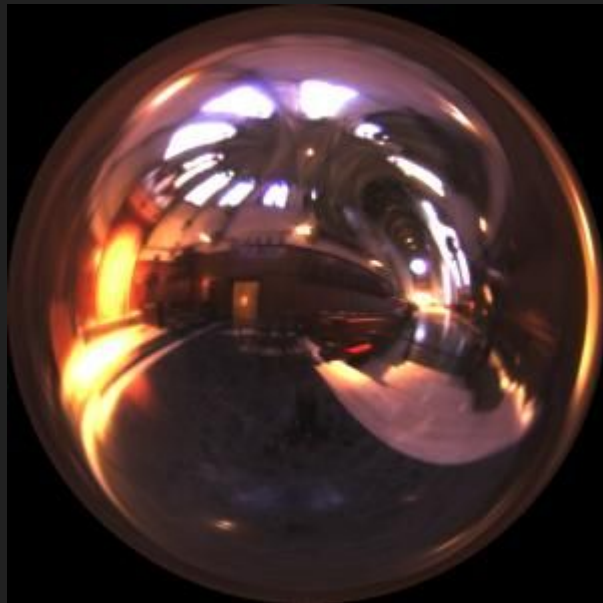
Possible methods:

- Mirror-ball photograph
- Fish-eye lens
- 360 degree camera

# Mirror-ball photograph

Method suggested in Paul Debevec's paper.

- Difficult to source material



# Fish-eye lens

Can capture 180 degrees of environment

- Requires stitching of several image





# 360 camera

Can capture 360 degrees of environment

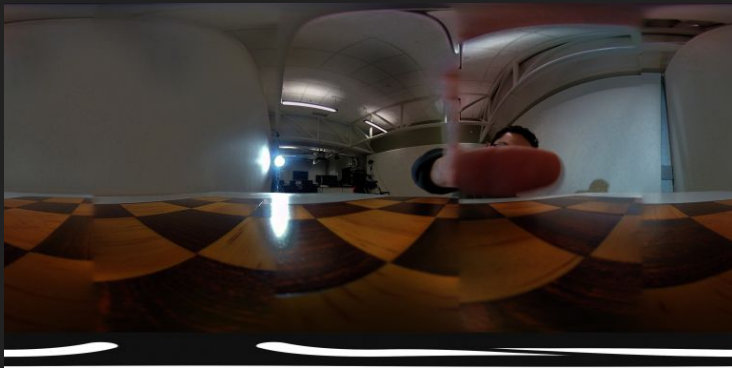
- IBL generated automatically
- No HDR



# 360 camera (continued)

Simulate HDR

Combine two lights



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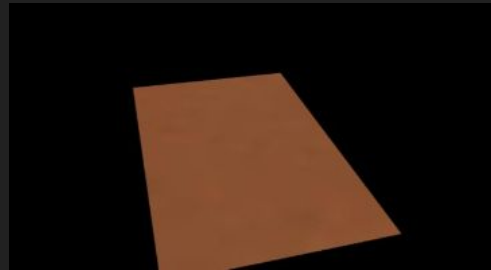
# Differential Rendering

To render a synthetic object inside of a background photograph, we require a light map, a local scene, and a local plane.

Five images are rendered:

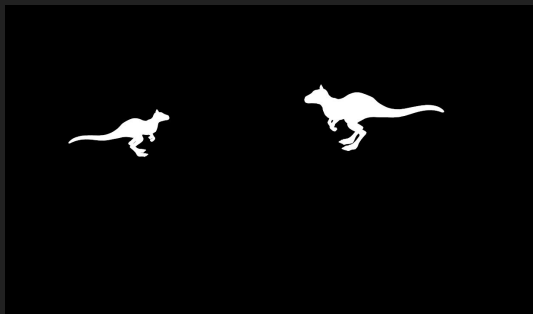
- The local plane
- The local scene
- The mask of the local scene
- The difference between the local scene and the local plane
- The final image

# Differential Rendering

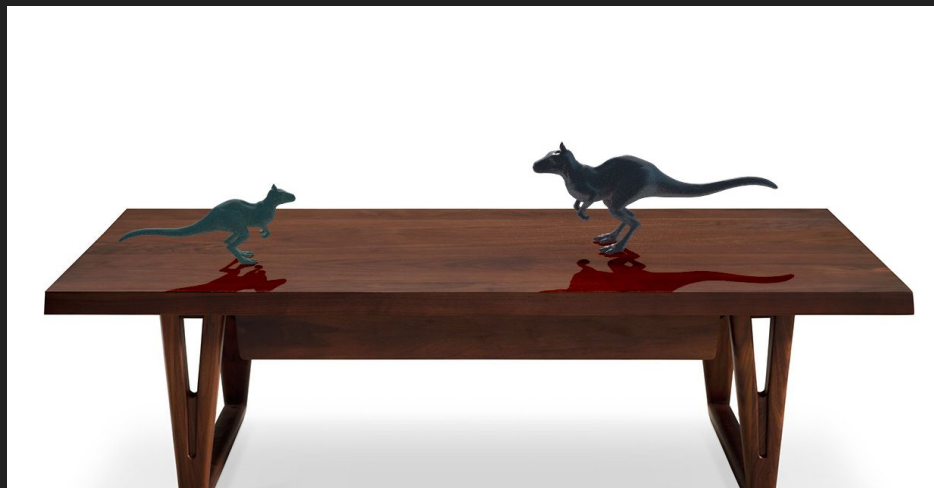
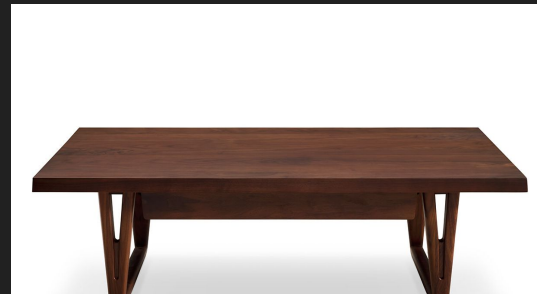




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# Scene Assembly: Models and Orientation

The local scene consists of two square planes representing the board and the table, positioned in front of the camera. The FOV is adjusted so the virtual board lines up with the checkerboard in the background image.

Chess piece OBJ files were downloaded from a model distribution archive, warped a little to match photographed pieces, transformed to their respective positions, and animated using keyframes.

A script was written to export the maya scene into the PBRT framework, rendering each frame.

# Scene Assembly: Materials

A *Plastic* material from the PBRT framework was used for the varnished wooden pieces. Roughness and specular coefficients were adjusted manually.

A procedural *checkerboard* texture was generated over the virtual board plane, with square colours approximating those in the background image. The board plane was given a very minor specular coefficient to match its real life counterpart.







# References

- Rendering Synthetic Objects into Real Scenes: Bridging Traditional and Image-based Graphics with Global Illumination and High Dynamic Range Photography: Paul Debevec, University of Berkely.
- Physically Based Rendering: From Theory to Implementation: Book by Matt Pharr and Wenzel Jakob.
- Piece Models: Obtained from Free3D.com: [https://free3d.com/user/printable\\_models](https://free3d.com/user/printable_models)