Stochastic Sampling in Computer Graphics

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Pixar

Introduction

Uniform Point Sampling

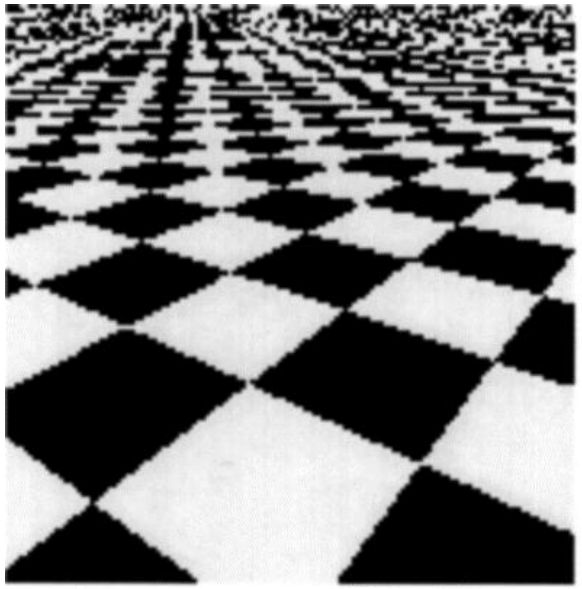
Poisson Disk Sampling

Jittering a regular grid

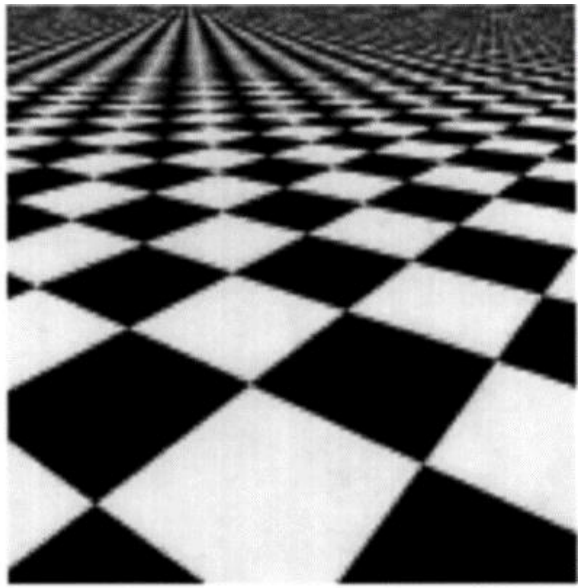
Distributed Ray tracing

Introduction

- Pixels are discrete -> CG is inherently a sampling process
- Can’t show more than 1 cycle per 2 pixels (Nyquist limit)
- Doing so results in jaggies / aliasing



(a)



(b)

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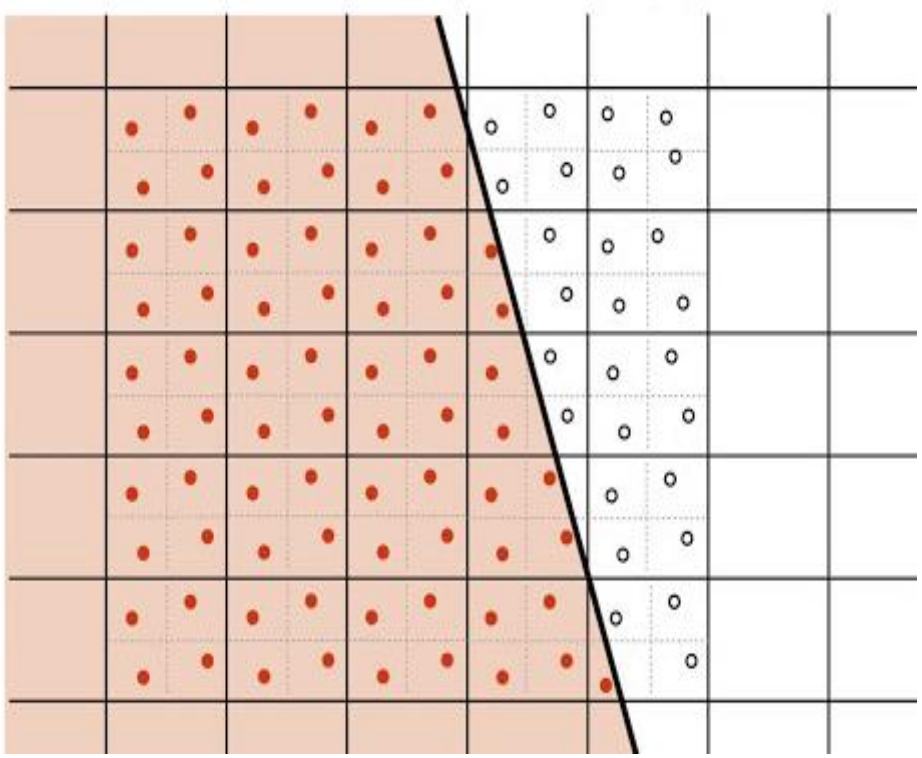
- Two existing approaches
  - Supersampling
    - Expensive
    - Helps but doesn’t solve the problem
  - Adaptive sampling
    - Sample around problem areas
    - Fixes certain problems, but not all
    - Complicates algorithm



Supersampling

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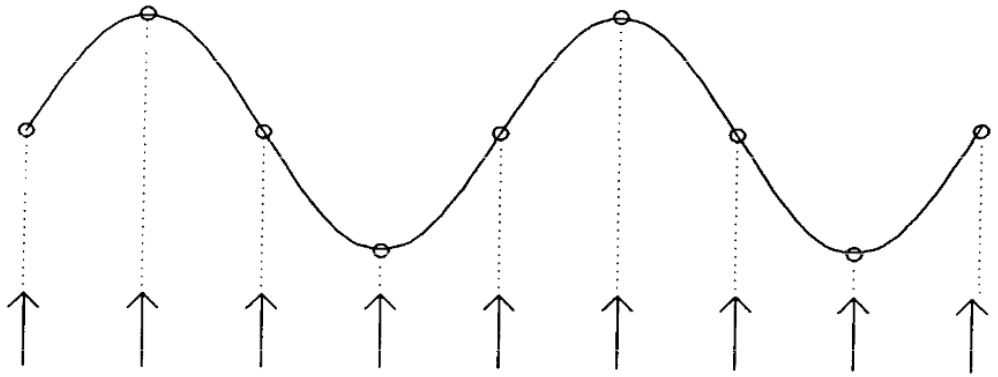
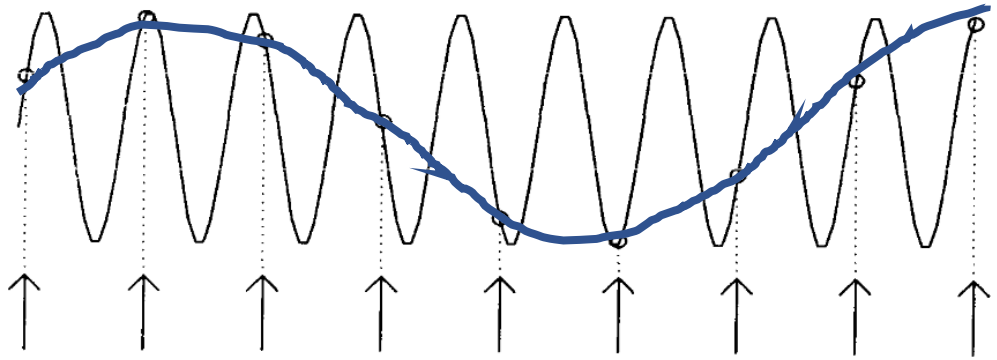
Uniform Point Sampling



(a) Point sampling within the Nyquist limit

Perfect reconstruction



(b) Point sampling beyond the Nyquist limit

Lower frequency reconstruction

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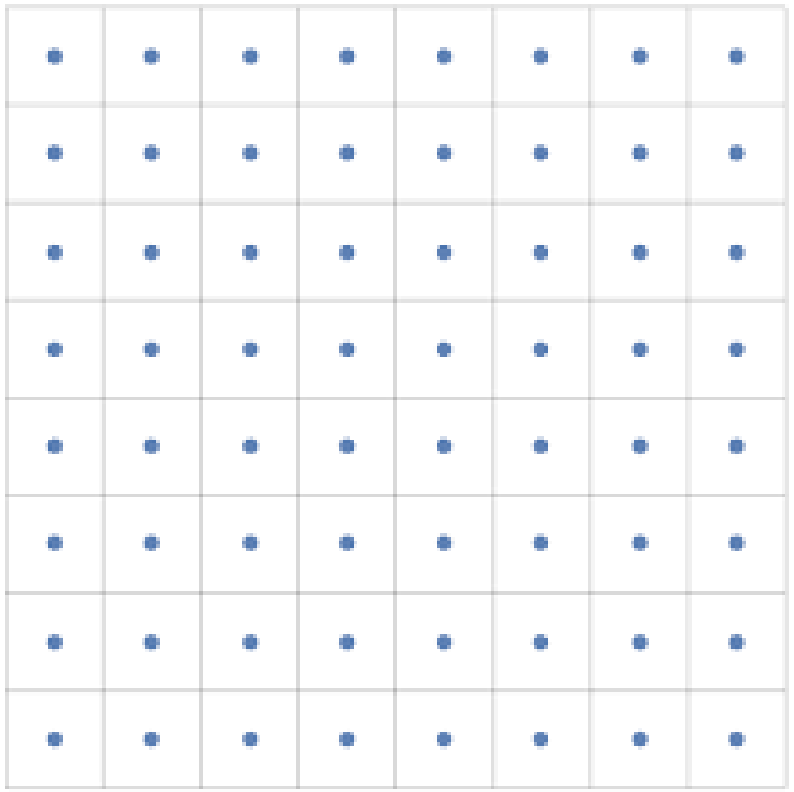

(b)

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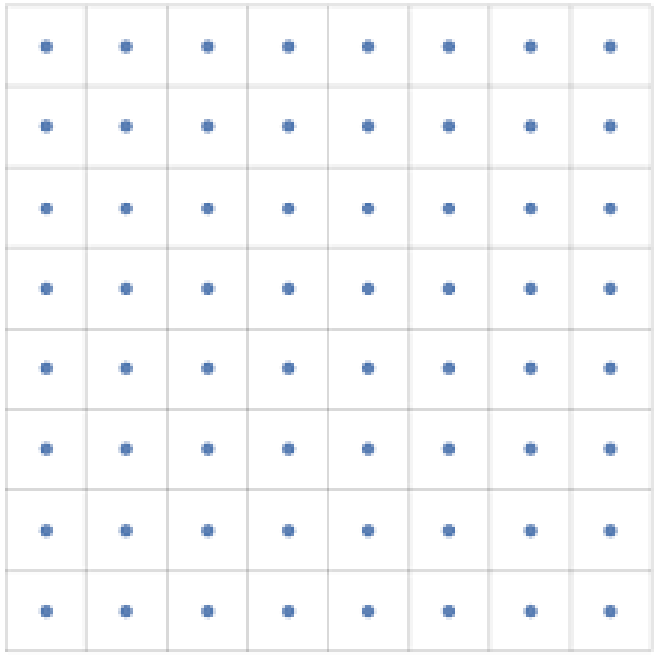

(b)

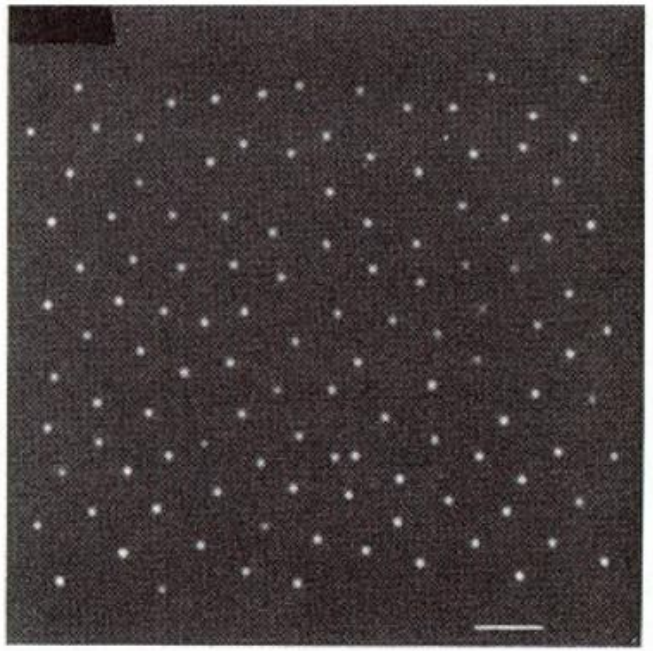

Fig. 3a. Monkey eye photoreceptor distribution.

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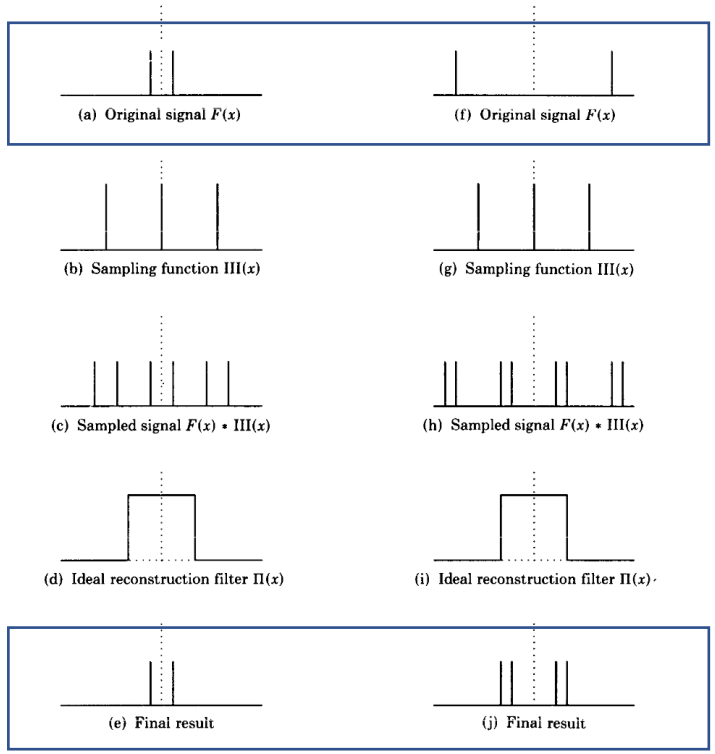

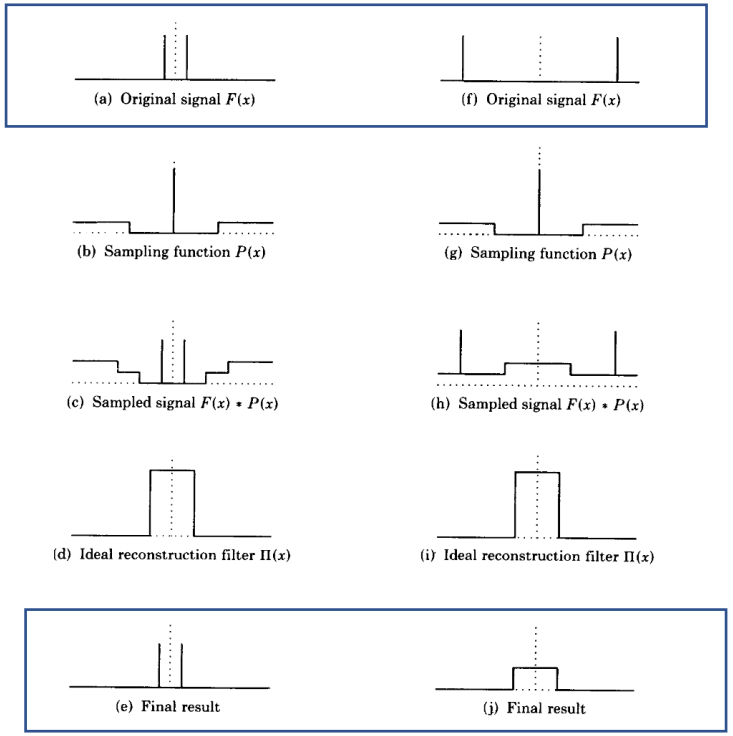

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Fig. 14a. *1984*, by Thomas Porter.

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Conclusion

- Sampling with non-uniform locations -> High frequencies turn into noise instead of aliasing

- Distributing samples cleverly make effects such as motion blur, depth of field, penumbra, and more possible and relatively simple.