Modeling and Simulation of a Color Printer Pipeline

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**Introduction**

- **Digital halftoning**
  - Converts a continuous tone image to a binary image
  - Creates the *illusion* of continuous tone
- **Current halftoning methods (see handout)**
  - Clustered dot dither
  - Dispersed dot dither
  - Error diffusion [Floyd and Steinberg, 1975]
  - Blue-noise mask [Mitsa and Parker, 1992]
  - Direct binary search [Analoui and Allebach, 1992]
  - Green-noise halftoning [Levien, 1993], [Lau, Arce and Gallagher, 1998]
Color Printer Pipeline

Color Image → Color Transform → Image Scaling → Halftoning → JBIG2 Compression

Encoder

JBIG2 Bitstream → JBIG2 Decoder → Image Scaling → Halftoning → Halftone Image

Decoder

optional
Vector Color Error Diffusion Halftoning

- Each pixel is a vector of color plane values (e.g. RGB)
- Error filter has matrix valued coefficients
- Adapt error filter coefficients [Akarun, Yardimci and Cetin 1997]

\[
\begin{align*}
    t(m) &= H(m) \ast e(m) \\
    &= \sum_{k \in S} H(k)e(m - k)
\end{align*}
\]
The JBIG2 Halftone Codec

- The JBIG2 standard [Howard, Kossentini, Martins, Forchhammer and Rucklidge, 1998]
  - Allows lossy compression
  - Defines decoder behavior (encoder optimizations possible)
- Lossy halftone coding
Modeling

- **Domain**
  - Synchronous Data Flow (SDF), [Lee, 1987]

- **Implementation**
  - Ptolemy
  - Stars in C++/C

- **Goal**
  - Simulation and testing of printer pipelines
  - Typical optimizations
    - Optimize halftoning for compression [Wong, 1994]
    - Optimize encoder for a given decoder [Kam, Wong and Gray, 1999]
  - Measure coding rate and image quality tradeoffs