Halftoning for 3DP: Optimal Dithering Pattern

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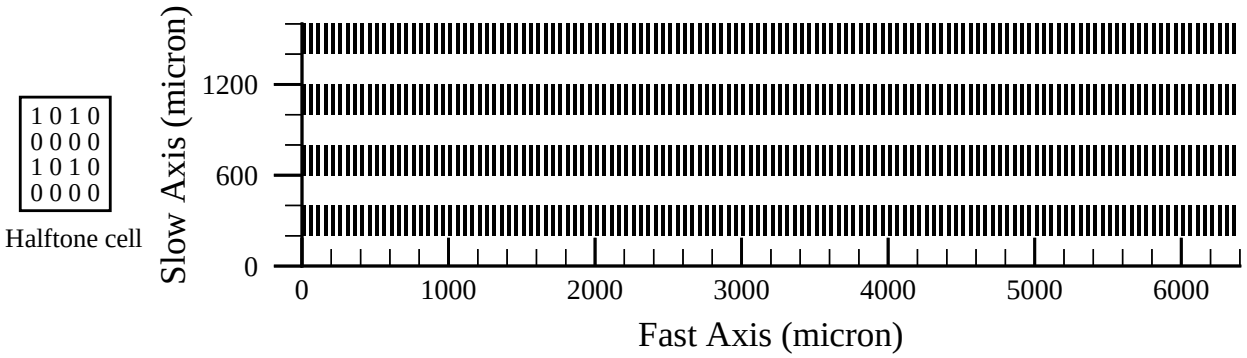
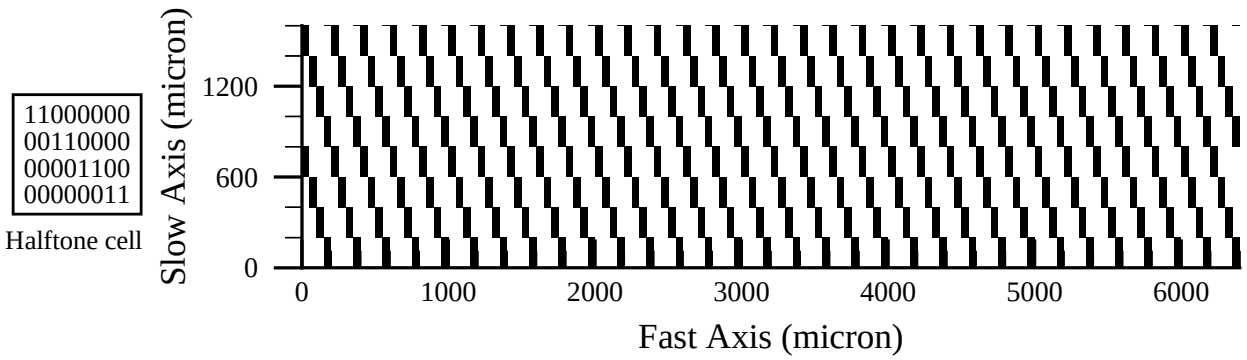
- **Objective:** Representation of *continuous-tone* material composition in a *point-wise* fashion for 3DP
- **Approach:** Development of a *halftoning technique*
  - Minimization of low frequency textures
  - Minimum run-length requirement
- **Results:**

Conventional dispersed-dot ordered dither



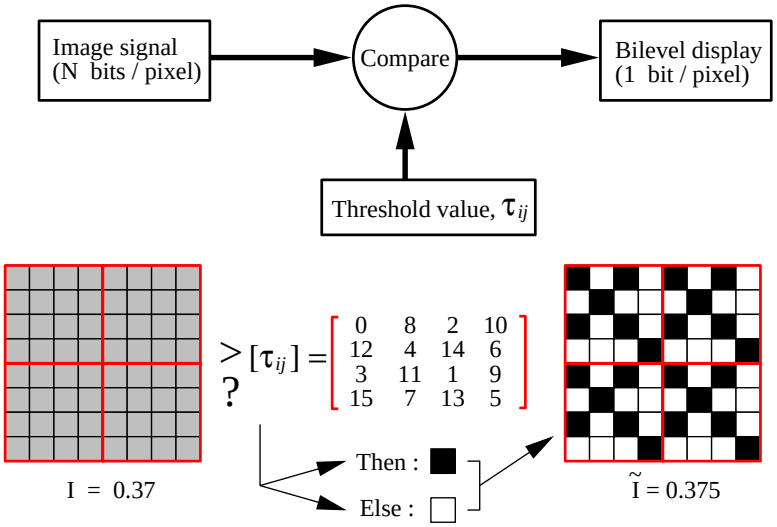
Proposed algorithm



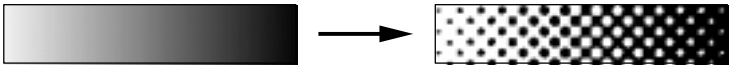
- **Plans:**
  - Construction of *interfaces* for data exchange
  - Extension to *volume* halftoning

Halftone Approximation

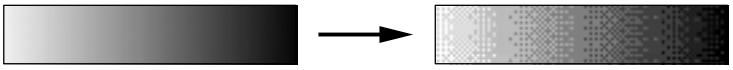
Simulation of continuous-tone gray scales for *bilevel* displays and hardcopy devices



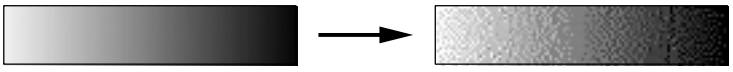
- Clustered-dot ordered dither:
  - *Less possibility* of missing droplet placement
  - Undesirable *low frequency textures*



- Dispersed-dot ordered dither:
  - *High frequency* fidelity
  - Need to specify the *minimum run-length* (> 1)

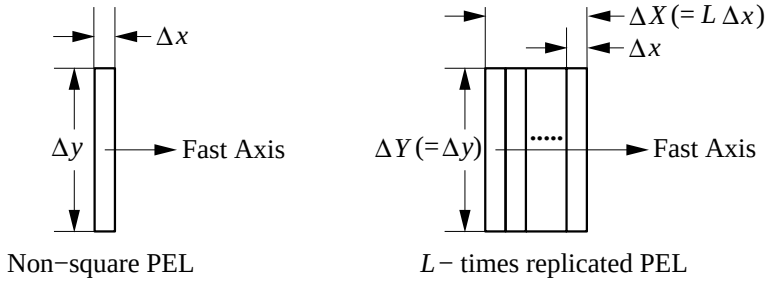


- Error diffusion algorithm:
  - *More precise* description of material composition
  - Hard to utilize *pattern memories* of 3DP machine



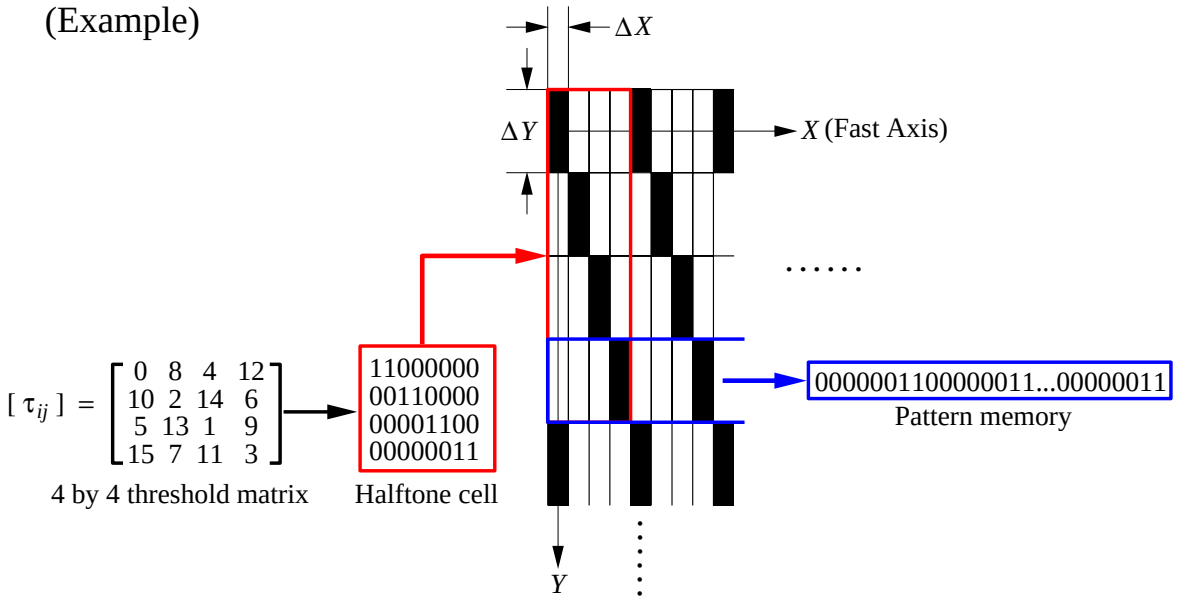
Optimal Dithering Pattern

- Minimum run-length (L) requirement:
  - Replication of each PEL of a halftone cell L-times along the fast-axis direction



- Construction of threshold matrix:
  - Computation of a *sequence of droplet placement* in L-times replicated PELs (AR $= \frac{\Delta Y}{\Delta X}$) of a 2D halftone cell that *minimizes* low frequency textures
- Extraction of pattern memories:
  - For the *efficient* description of an area of *uniform* material density

(Example)

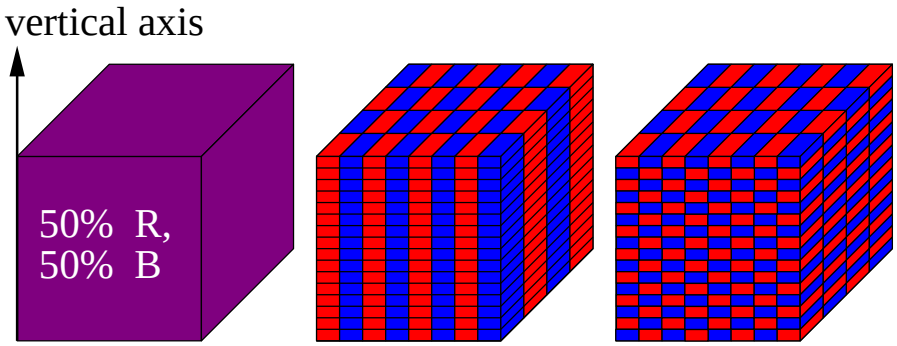


An area of uniform intensity (level 5, $L = 2$, AR $= 4$)

Current Issues

- Construction of interfaces:

- Volume halftoning: To minimize *low frequency textures* and to prevent successive layers being printed with the *same patterns* when print ing a volume of *constant* material density



(a) Idealized model (b) Replication of each layer (c) Result by 3D halftoning