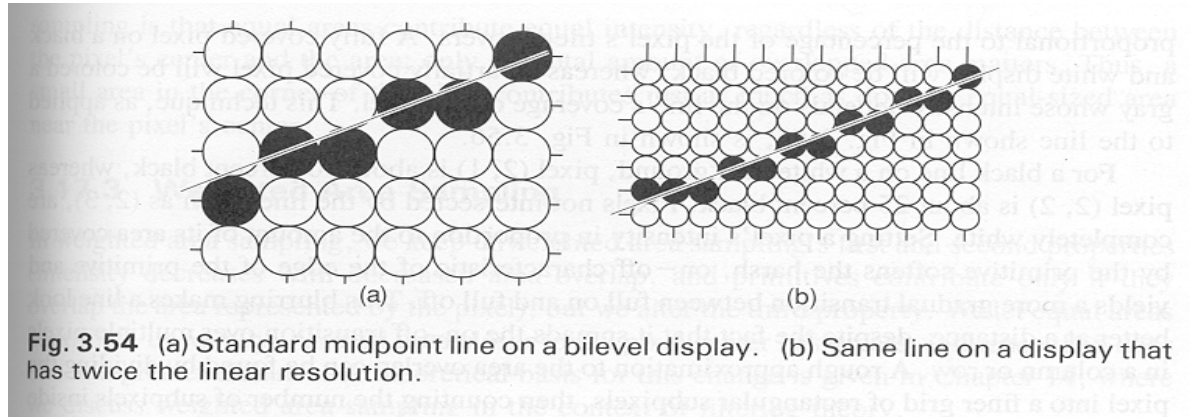


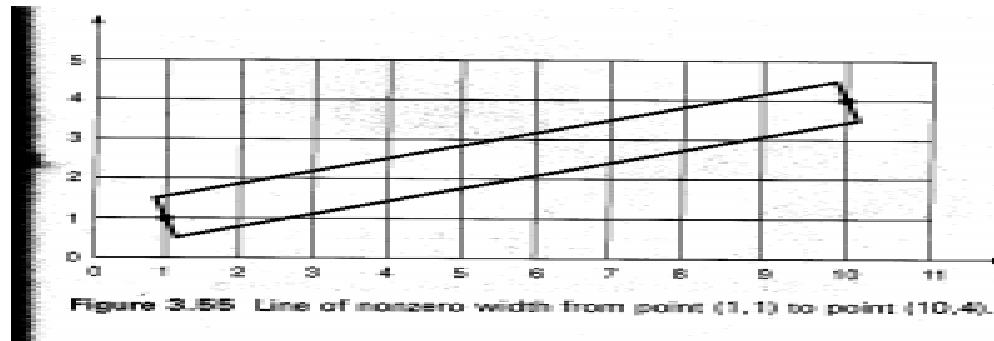
Aliasing and Antialiasing

- *Aliasing*: name given to jagged effect of lines
 - name comes from signal processing (see FvD Ch 14)
- Jagged effect caused by finite size of pixels
 - when change rows get step
- Increase resolution steps (jaggies) get less steep
 - double resolution -> quadruple memory, bandwidth, and scan-conversion time



Unweighted Area Sampling

- Assume background white - lines black
- Recognize that primitive has non-zero width
 - even thinnest line is 1 pixel thick
- Consider line as (thin) rectangle
 - covers different (square) pixels to different extent
- In most cases should not set a single pixel to black
 - Set intensity of pixel differently for each pixel covered
 - Only horizontal and vertical lines effect only 1 pixel per row



Unweighted Area Sampling

- Simplest assumption on geometry of pixels
 - nonoverlapping square tiles - grey scale display
 - line contributes to intensity proportional to area of pixel's tile covered
 - pixel (2,1) is 70% black, (2,2) is 25% black
 - makes line appear better at a distance

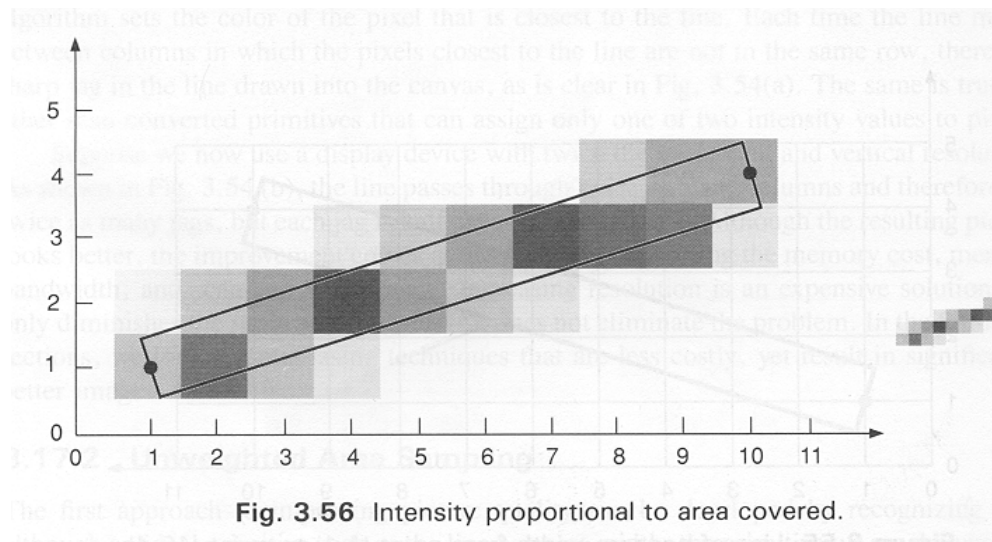


Fig. 3.56 Intensity proportional to area covered.

Properties of Unweighted Area Sampling



- 1. Intensity decreases with increasing distance from pixel to edge
- 2. Primitives do not influence pixel they do not intersect
- 3. Equal areas contribute equal intensity
 - distance from pixel center to area overlapped
 - small area in corner contributes same as equal-sized area in center

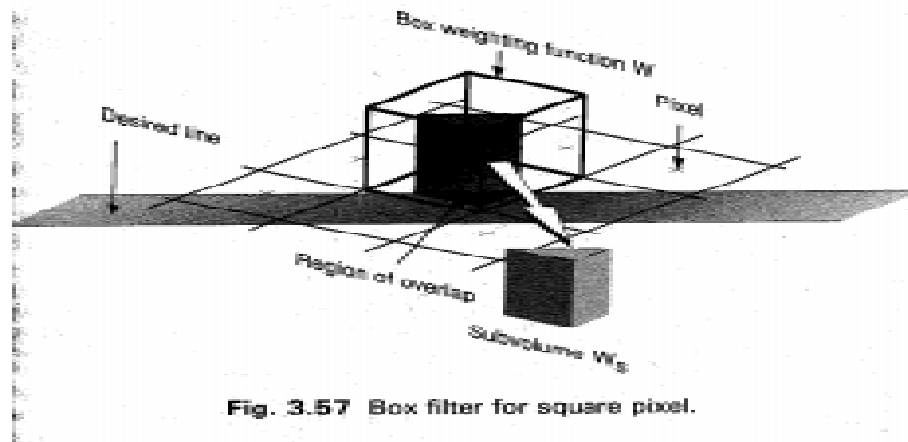
Weighted Area Sampling



- Change third property of *Unweighted Area Sampling*
 - areas closer to the pixel center contribute more
- Need to change “geometry” of pixel to preserve 2nd property
 - pixel is circle larger than square
 - if line intersects circle it contributes
- Terms *weighted* and *unweighted* come from idea of *weighting function* that determines effect of area dA on intensity of pixel

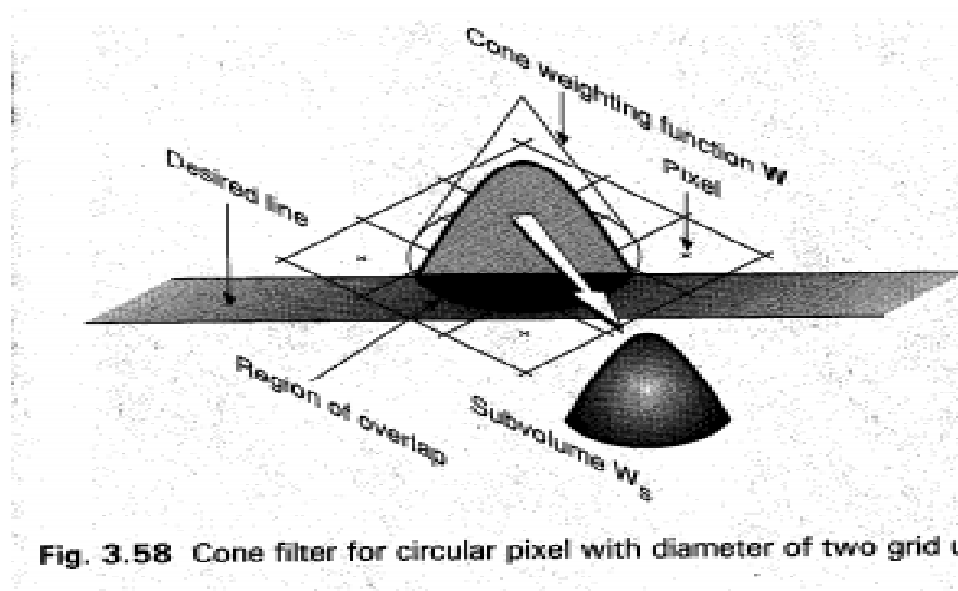
Weighting Function: Unweighted Area Sampling

- *Weighting Function $W(x,y)$*
 - height at (x,y) gives weight for area dA at (x,y)
 - unweighted - graph of W is box i.e. weight is constant
 - Intensity is $I_{\max} \int_{\text{Area of overlap}} W(x,y) dA = I_{\max} W_s$
where W_s is area of wedge



Weighting Function: Weighted Area Sampling

- *Weighting Function $W(x,y)$*
 - choose simplest graph with height proportional to distance
 - graph of W is circular cone
 - choose radius as distance between pixel centers



Consequences of Weighting

- Pixels covered by line of width one not so bright
 - not all *support* of weighting function covered
- Pixels that would not have received contribution do
- Pixel can have intensity I_{\max} if line is wide enough to cover support of W
- Contrast is decreased
- Even horizontal and vertical lines influence more than 1 pixel per row
- Why rotational symmetry?
 - Simpler: calculation don't depend on angle of line
 - Theoretically optimum

Gupta-Sproull Antialiasing



- Precomputes the subvolume of a normalized filter function and stores them in a table
- Make pixel support circle of radius 1
- Line of units thickness intersects between 2 and 5 supports in a column, typically 3
- Original table gives for 4 bit display
- More bits - more accuracy required in distance

Gupta-Sproull Antialiasing



- Can modify Bresenham's Algorithm
 - Still choose between E and NE pixels
 - Now need to set intensity of pixel and 2 nearest neighbors
 - can formulate as incremental algorithm
 - Other issues:
 - | need to antialias the end points separately
 - | lookup table applies only to line of one thickness
 - | more general discussion Foley & van Dam Ch. 19.3
 - | Characters: can filter 19.4 or manually soften