Basic Dense Stereo Depth Calculation

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Dense Depth Data

Problem: have depth only at triangulated feature locations

Solution 1: Linear interpolate known values at all other pixels

Solution 2: Correlation-based stereo

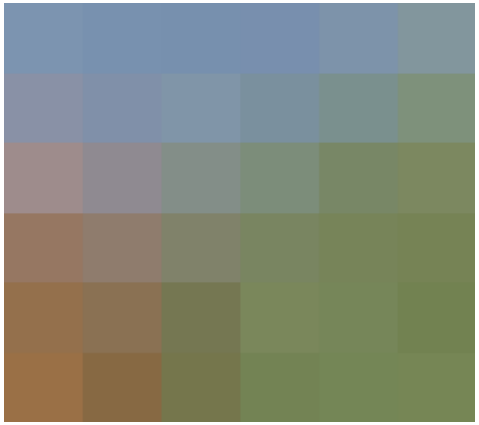
Use pixel neighborhoods as features

Triangulate depth at every pixel

But needs to find matching pixel - not easy

Correlation based stereo

- Use stereo image pair
- Features are neighborhoods at each pixel



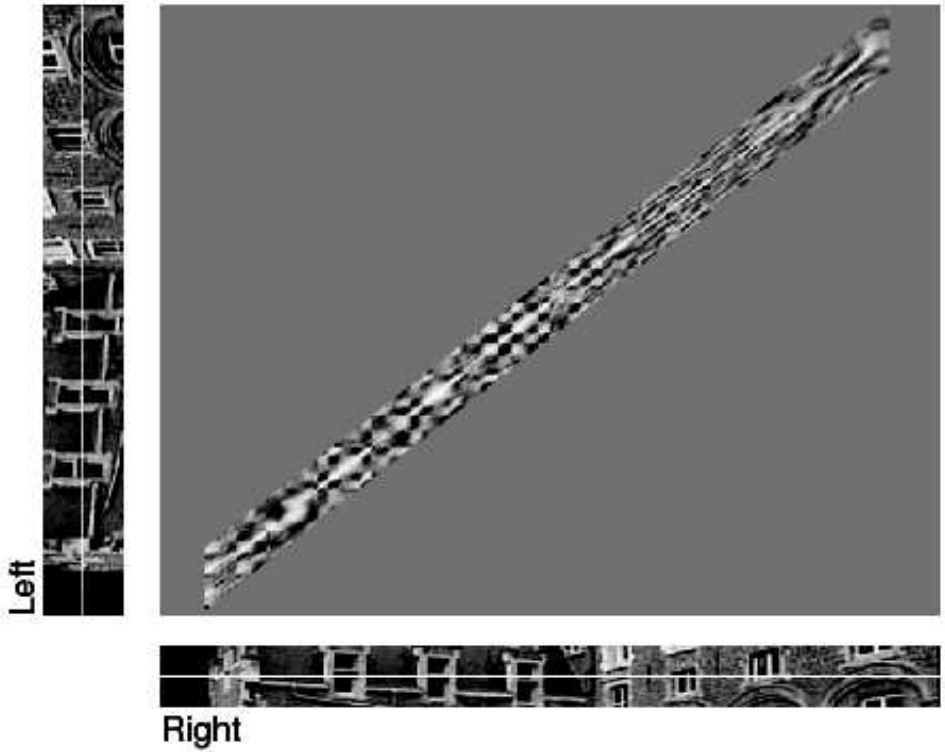
- Match using similarity metric: SSD - Sum of Squared Differences (of pixel values) of left image at (u, v) to right image at (r, s):

$$SSD(u, v, r, s) = \sum_{i=-\frac{N}{2}}^{\frac{N}{2}} \sum_{j=-\frac{N}{2}}^{\frac{N}{2}} (L(u+i, v+j) - R(r+i, s+j))^2$$

Finding best match

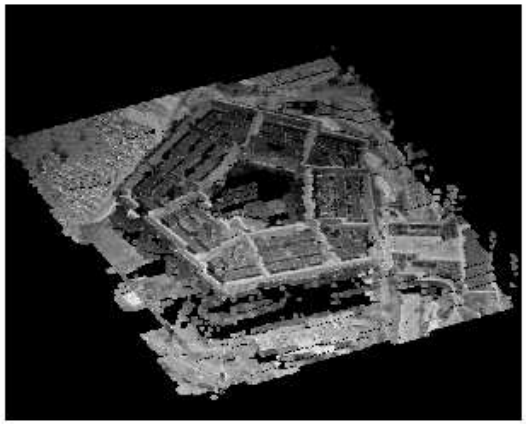
For each scanline on rectified image pair:

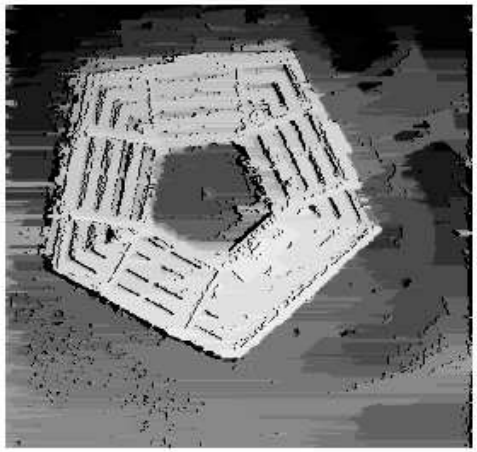
1. Build array of all possible matching scores

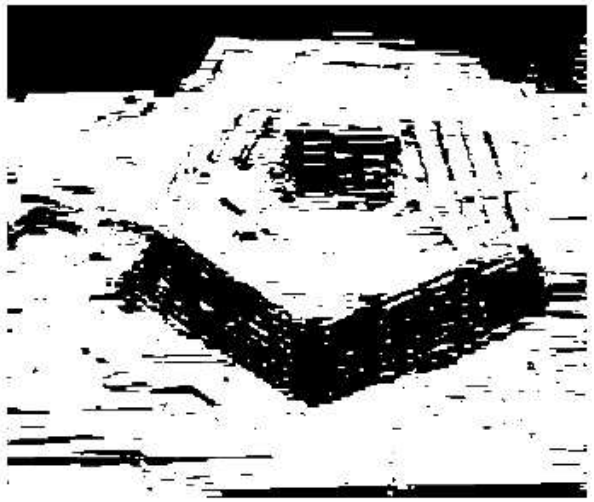


2. Dynamic programming finds lowest cost path (bright line thru middle of array above - optimisation problem)

Dense Stereo Results







Technique = [Cox et al. 1996]

Commercial Dense Stereo Results

What We Have Learned

- Can use local intensity to make pixel-to-pixel matches
- Can triangulate every pixel to get dense depth data
- Matching errors still happen