Binocular Stereo Vision

Region-based stereo matching algorithms

CS332 Visual Processing
Department of Computer Science
Wellesley College

Processing stereo images

left

right

- extract features from the left and right images, whose stereo disparity will be measured
- match the left and right image features and measure their disparity in position

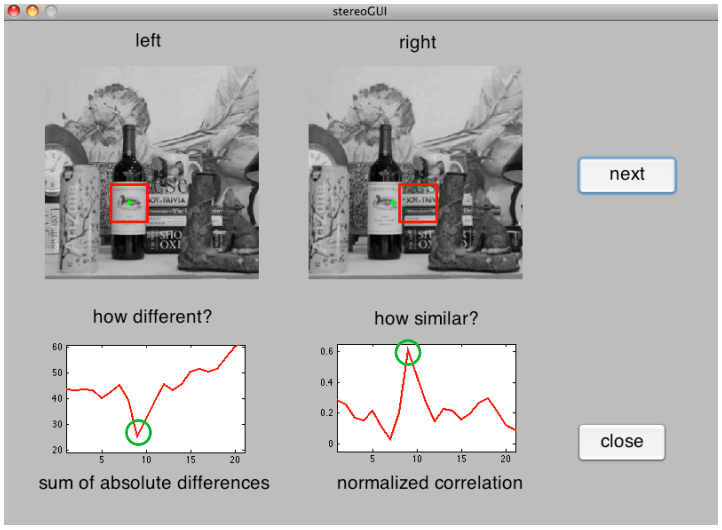
  "stereo correspondence problem"
- use stereo disparity to compute depth

Constraints on stereo correspondence

- Uniqueness
  - each feature in the left image matches with only one feature in the right (and vice versa…)
- Similarity
  - matching features appear "similar" in the two images
- Continuity
  - nearby image features have similar disparities
- Epipolar constraint
  - simple version: matching features have similar vertical positions (in general, stereo projection is more complex)

1-3

Solving the stereo correspondence problem



1-4

Measuring goodness of match between patches

(1) sum of absolute differences

$$(1/n) \sum_{\text{patch}} | p_{\text{left}} - p_{\text{right}} |$$

optional: divide by n = number of pixels in patch

(2) normalized correlation

$$(1/n) \sum_{\text{patch}} \frac{(p_{\text{left}} - \overline{p_{\text{left}}})\,(p_{\text{right}} - \overline{p_{\text{right}}})}{\sigma_{p_{\text{left}}}\,\sigma_{p_{\text{right}}}}$$

σ = standard deviation of values within patch

1-5

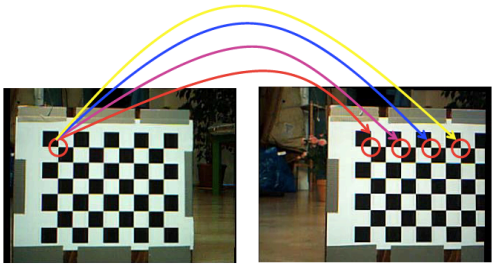
Region-based stereo matching algorithm

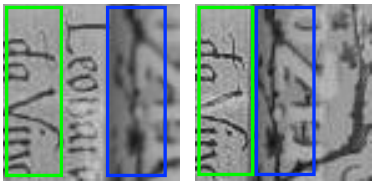
```
for each row r
    for each column c
        let p_left be a square patch centered on (r,c) in the left image
        initialize best match score m_best to ∞
        initialize best disparity d_best
        for each disparity d from −d_range to +d_range
            let p_right be a square patch centered on (r,c+d) in the right image
            compute the match score m between p_left and p_right
                    (sum of absolute differences)  (normalized correlation)
            if (m < m_best), assign m_best = m and d_best = d
        record d_best in the disparity map at (r,c)
```

How are the assumptions used??

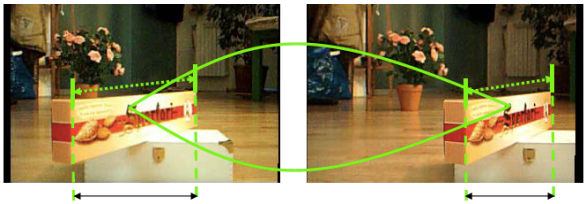
1-6

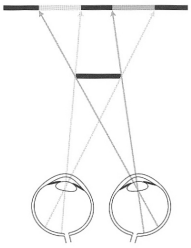
The real world works against us sometimes…





left right





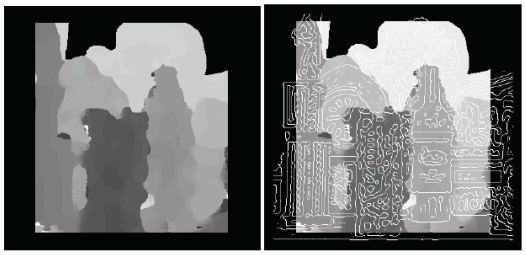
1-7

Example: Region-based stereo matching, using filtered images and sum of absolute differences

(from Carolyn Kim, 2013)

(a)

(results before improvements)



1-8