Fast Area-based Stereo Algorithm

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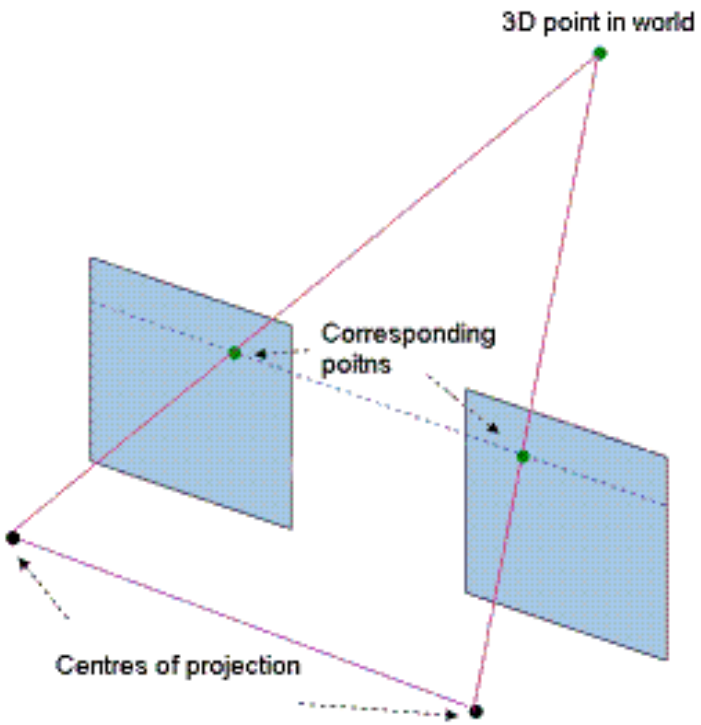
Automated Stereovision

- Without human interaction
- Most universal from all distance measuring methods
- Environment reconstruction, robot control, virtual reality
- Fast technological progress in last years

Basic problem

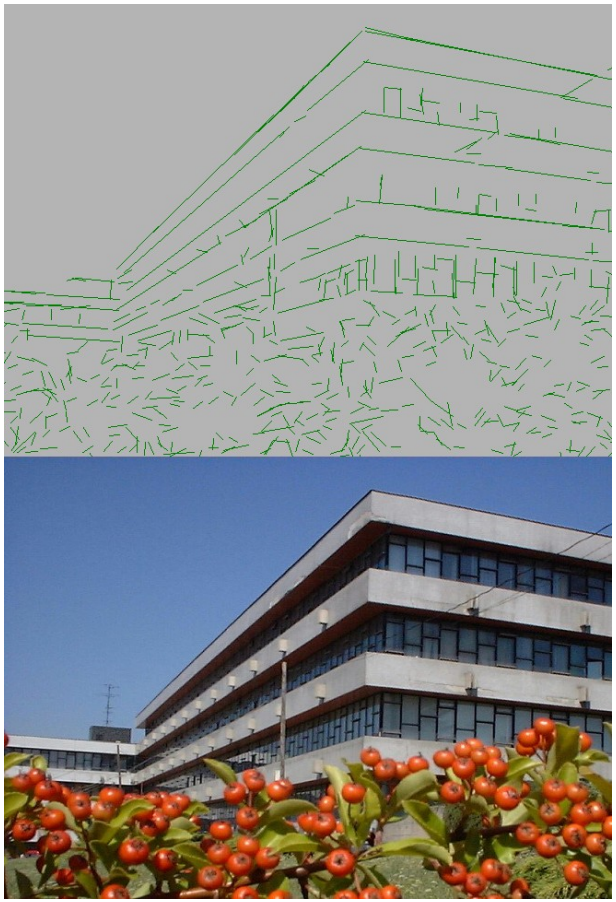


- 1. find the images of real points in both pictures (corresponding points)
- 2. locate points into 3D space (find the depth of the points)
- 3. final model creation

Area-based stereo

- Principle : Similarity of two locations in different pictures can be enumerated
- Similarity is computed from local neighbourhood
- Correlation-based stereo

Feature-based stereo



- Principle : There are some “features” in the scene which are not dependent on the view
- Objects are detected in first image, then matched with objects in second image
- Only some objects can be matched

Comparison

- Feature-based
  - Sparse set of point (grouped in clusters)
  - Used in special tasks
  - High accuracy
  - Faster then area-based
  - Easy to use special constraints
- Area-based
  - Dense set of point
  - Universal
  - Inaccurate
  - Not very fast (but some of them can run in real time)
  - Easy for implementation
  - In human vision

Constraints

- **Uniqueness** - Almost always, a given pixel or feature from one image can match *no more than one* pixel or feature from the other image.
- **Continuity** - The cohesiveness of matters suggests that the disparity of the matches should vary smoothly almost everywhere over the image.
- **Ordering** – If point *m* is *to the left* of *n* then it's corresponding point *m*' should also be *to the left* of *n*'.
- **Left-Right consistency** – Corresponding point *m'* should be confirmed by searching it's corresponding point in first image.

- **Epipolar** - Given a point *m* in the left image, the corresponding point *m*' must lie on the epipolar line.

False Epipolar Constraint

- Addition to epipolar constraint
- It is possible to define exact area in epipolar line, where the corresponding point is present.

Method Principle

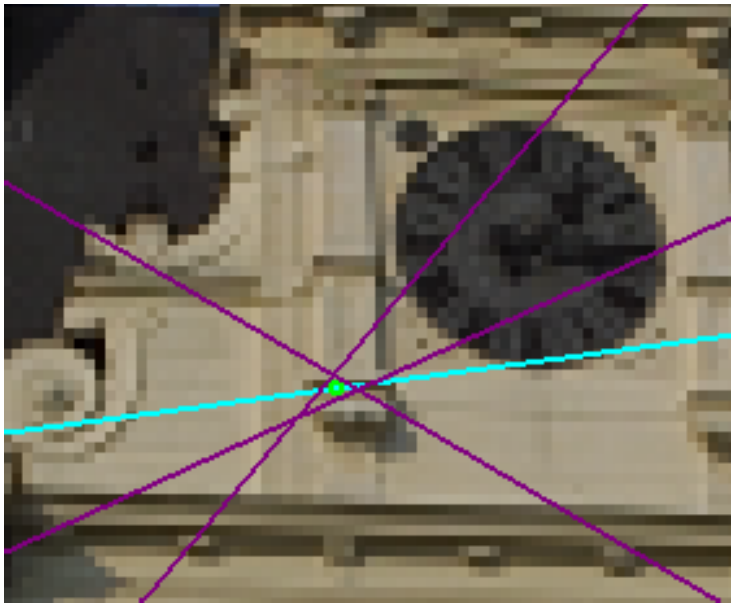
- False Fundamental Matrix has similar properties as Fundamental Matrix : Corresponding point is located near it's epipolar line.
- Intersection of epipolar line and false epipolar line defines the area, where corresponding point is located.

Computing of False Fundamental Matrix

- Linear 8-point algorithm for fundamental matrix computation can be modified to compute false fundamental matrix.
- Input points has to be modified with some error values.

Extensions

- Applying more false fundamental matrices
- Area with corresponding point can be defined by leftmost and rightmost intersection



False Epipolar Constraint as Weak Constraint

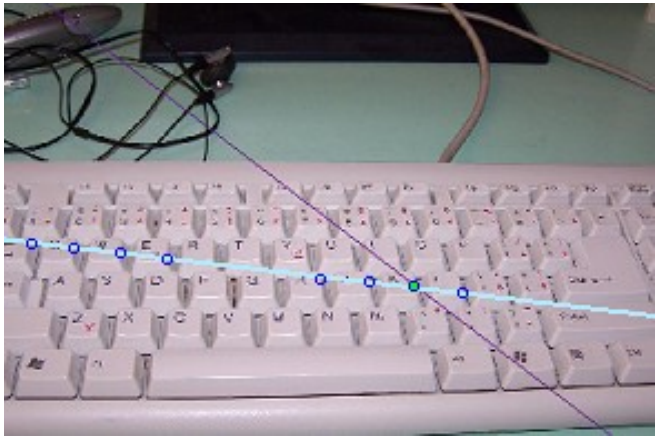
- Problem when positions of adjacent points are discontinuous in second image.
- Problem can be avoided :
  - Limit to near-based stereo
- Problem can be solved :
  - Increase search area
  - Compute more false fundamental matrixes from different set of points

Test Results

- Speed increases significantly for higher resolutions.
- Time required for 500 corresponding points detection :

Resolution	EC [s]	EC+FEC [s]
400x300	15	10
800x600	31	11
1200x900	59	13
1600x1200	97	16

- Search area reduced from 0.95% to 0.08%
- Accuracy increased.



Summary

- Using false epipolar constraint, only 1/6 of epipolar line has to be searched for corresponding point.
- Accuracy is greatly increased for pictures with many similar objects
- False fundamental matrices can be pre-computed for stereo systems with stabile calibration.
- Can be used in any algorithm where epipolar constraint is used

Thanks for your Attention

- Michal Récky
- www.laker.szm.sk/thesis.html