3-D Reconstruction through Monocular Vision for Mobile Devices

Alexandr Prozorov
Vladimir Volokhov
Andrew Priorov

Image Processing Laboratory
Yaroslavl State University, Russia

Stereo Matching Algorithms

- match "features" and interpolate

- match edges and interpolate

- match all pixels with windows (coarse-fine)

- use optimization:
  - iterative updating
  - dynamic programming
  - energy minimization (regularization, stochastic)
 - graph algorithms

The correspondence problem

$$D = \{?,?,2,2,2,2,1,1,1,?,?,3,3,3,3\}$$
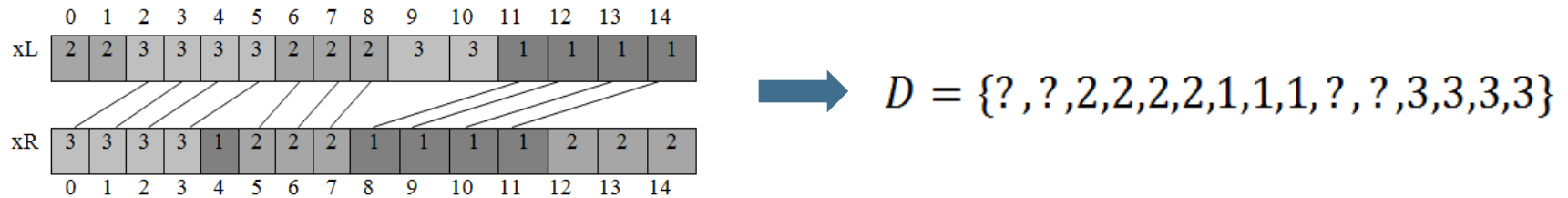
Typically, digital cameras of mobile devices have a significant amount of spurious artifacts in their image. The small size of camera matrix in the mobile devices causes a considerable distortion of the image through thermal noise.

To reduce the effect of such noise is supposed to use hierarchical method for calculating the stereo correspondence maps. The problem of stereo correspondence search is to computing the cross-correlation between the pixels of the left and right pictures.

Hierarchical Stereo Calculation
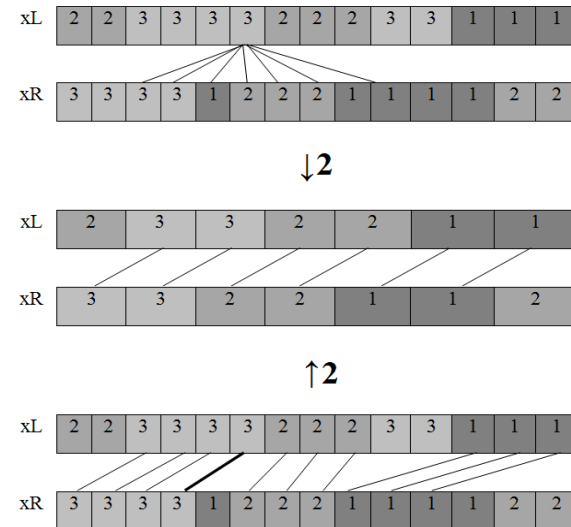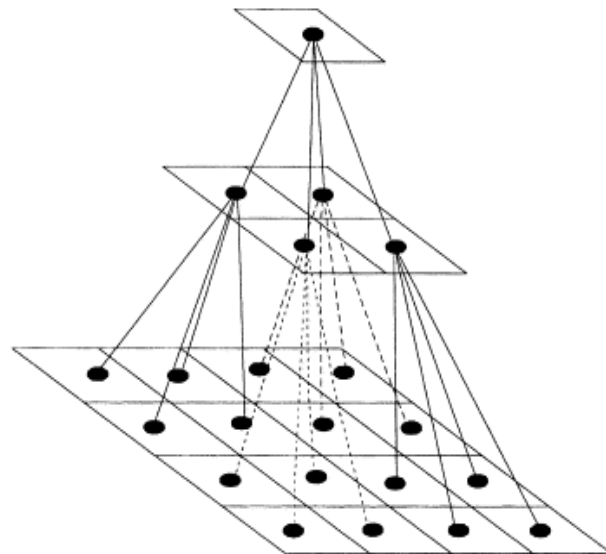
The hierarchical structure implies the creation of an image tree through the decimation of the image. The process of calculating the correct stereo correspondence is shown on slide. As the main part of a cost function we use the simplest case of dissimilarity function is to calculate an absolute difference between the brightness of pixels – sum of absolute differences. The advantages of this method are its simplicity and calculation speed.

Tsukuba Dataset
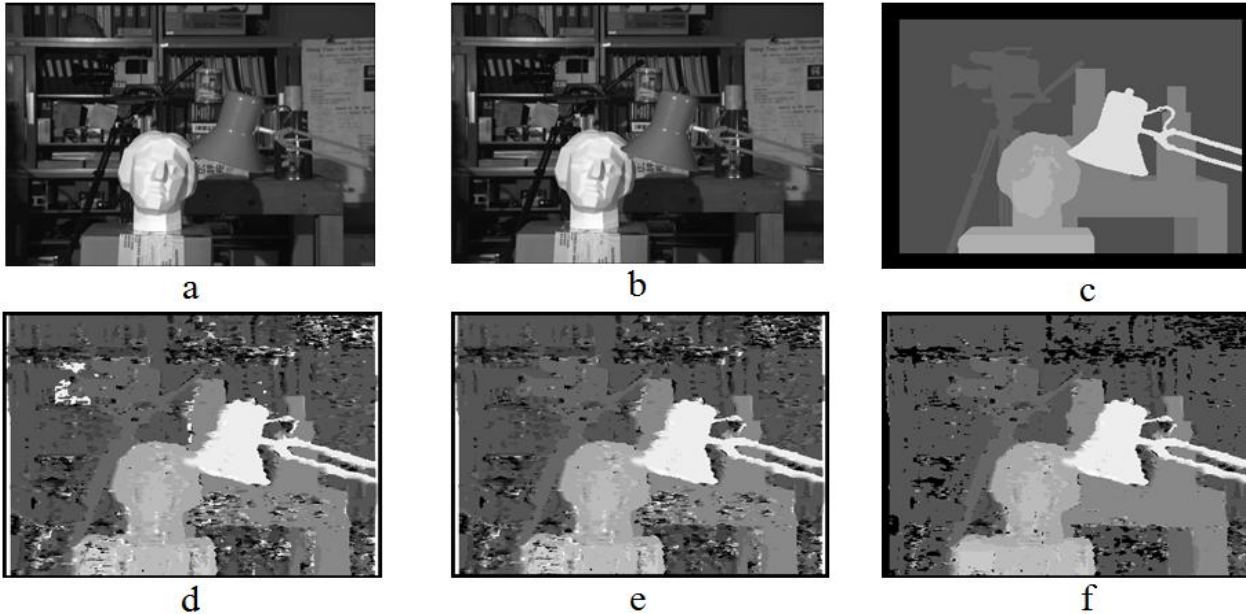
a),b) Tsukuba stereo pair
c) Ground truth
d) Simple DP method
e) Using hierarchical structure with 3 layers
f) Using hierarchical structure with 6 layers.

Feature Tracking
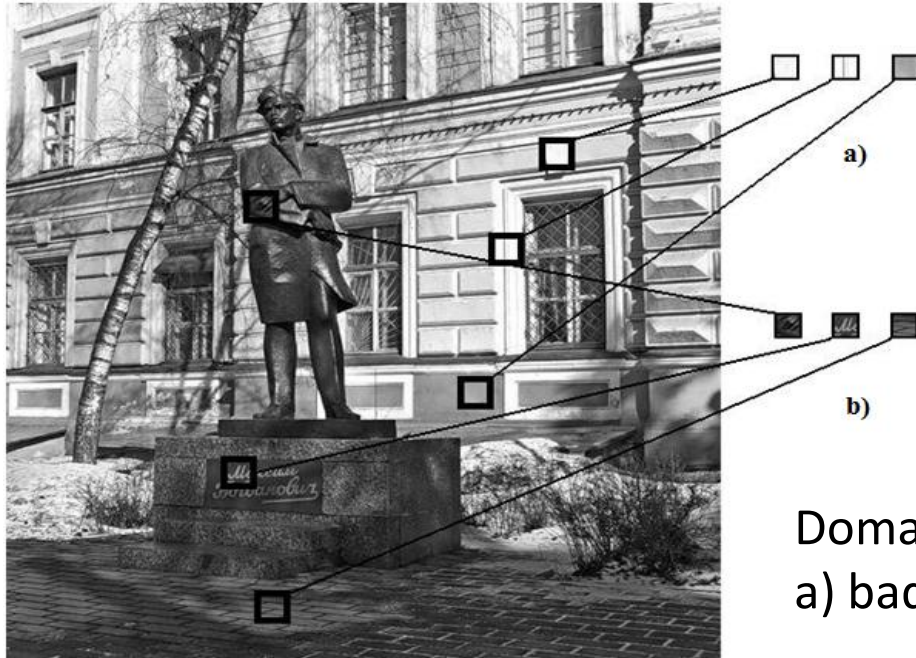
Domains for feature tracking:
a) bad, b) good.

Movements from frame to frame can be traced by the special points. It is most successful to track the flow of points, when the derivative of brightness has a local maximum. When the image is considered as a two-dimensional function, these features have enough information to track their movement between adjacent frames of a video stream.

Optical Flow Evaluation

Basic equation of the optical flow cannot be solved uniquely since it contains two unknown parameters.

The process of checking the vectors to the potential error is a necessary step in calculating the camera movement. There are different evaluation criteria for invalid vectors. The length of the vectors can be limited by a certain threshold. The threshold can be defined strictly, or adaptively.

Adaptive Errors Elimination:

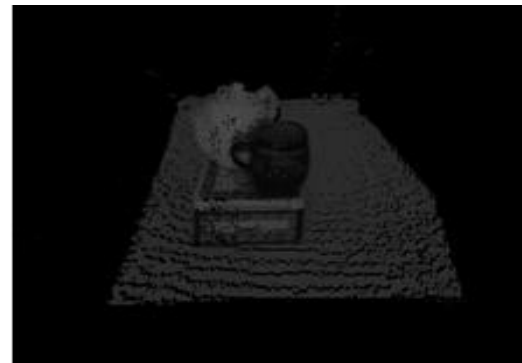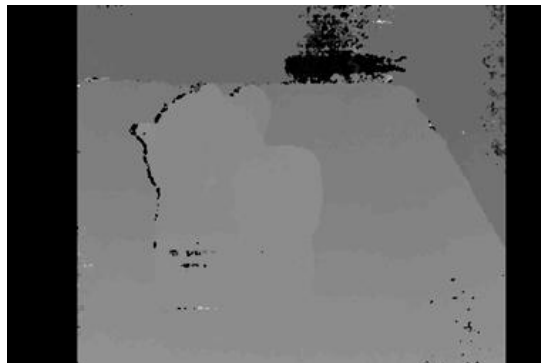| Found vectors | Errors | Result |

Results

The following figures show the results of the computation of depth map and 3d reconstruction.

The video sequence

Depth map   3D model

3-D Reconstruction through Monocular Vision for Mobile Devices

Alexandr Prozorov
Vladimir Volokhov
Andrew Priorov

Image Processing Laboratory
Yaroslavl State University, Russia