Practical Planar Metric Rectification

Artificial Perception Group

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applications

- Visual robot navigation
- pose estimation
- shape recognition, etc.

problem

automatic metric rectification of a plane from *interimage* homographies

requirements

- Computationally efficient, for real time rectification
- robust to image noise

general solution

1

- find the *circular points* (**4** d.o.f.)
- difficult nonlinear optimization problem

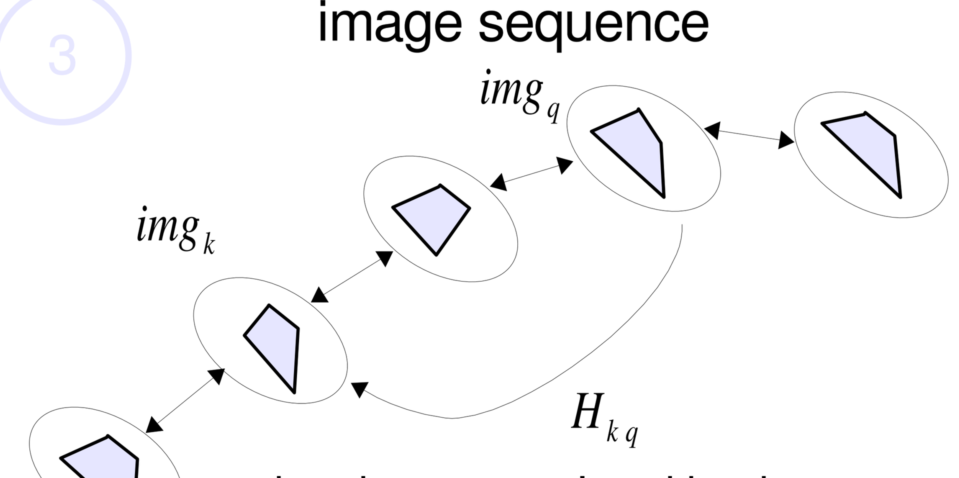
proposed solution

2

- assume *diag*(*f*,*f*,1) camera
- easier optimization to find just the *horizon* of the plane (**2** d.o.f.)
- even if the *f* of all views are unknown!

3

image sequence

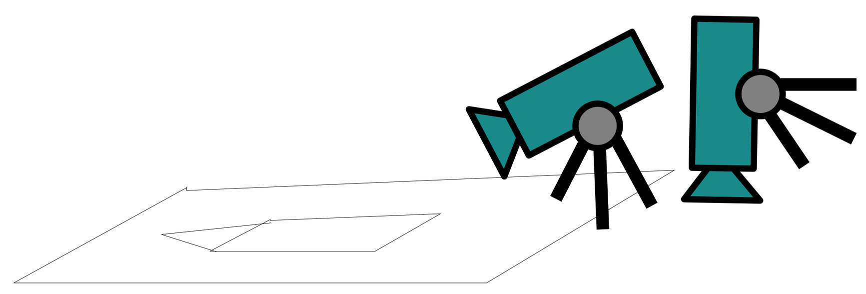


the views are related by the interimage homograhies

4

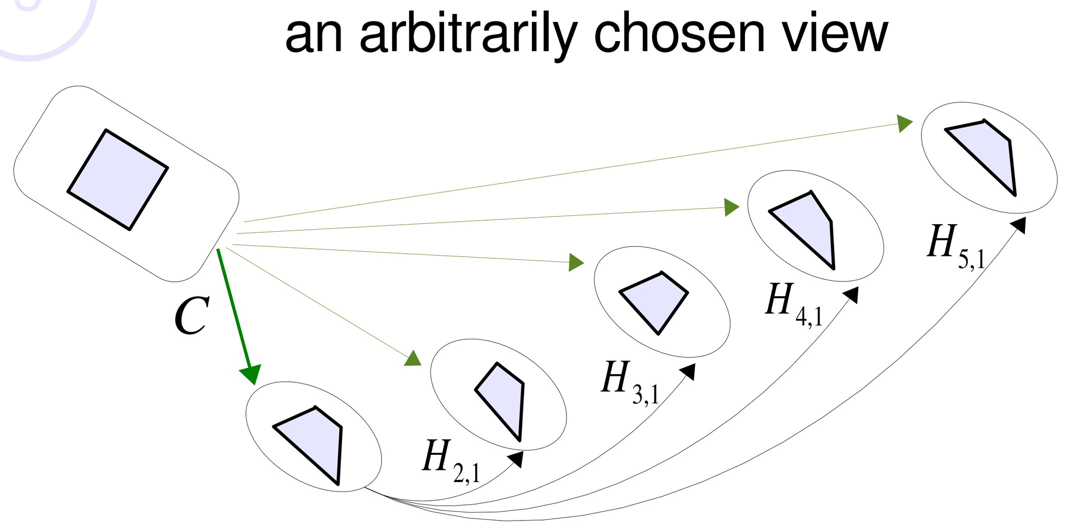
the solution *C* is a rotation which obtains a frontoparallel view

it has **3** essential d.o.f.: ***f*** and ***h*** = l'_∞



5

C is related to the camera of an arbitrarily chosen view



C converts image homographies into camera matrices:

$$C_k = H_{k,1} C$$

6

cost function

the homography floor-image *C* induced by a camera matrix verifies:

$$C^T \omega\, C = \begin{bmatrix} v & 0 & x \\ 0 & v & x \\ x & x & x \end{bmatrix}$$

and ω can be deduced from *C* in a diag(*f*,*f*,1) camera

key idea

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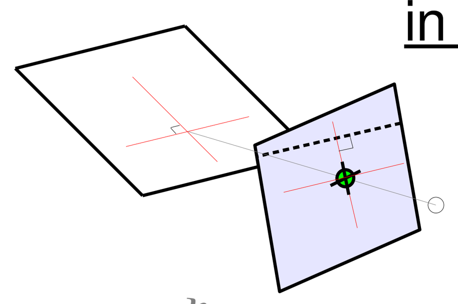
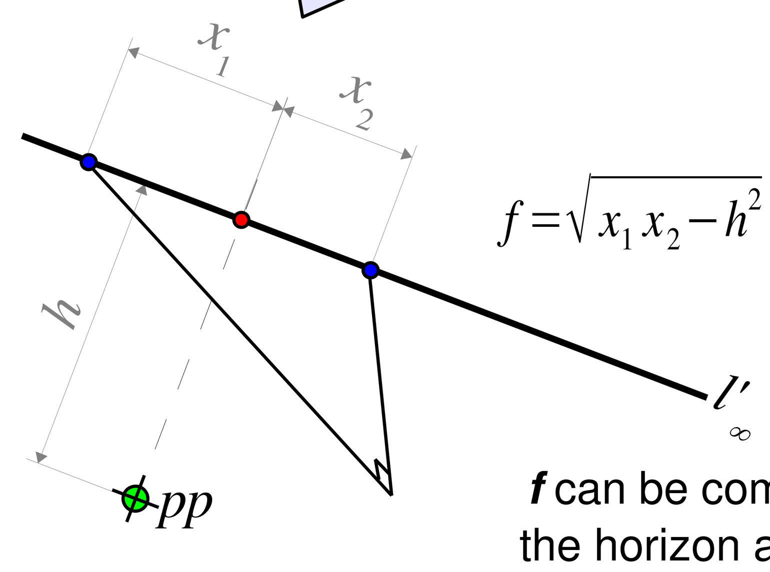
in a diag(f,f,1) camera



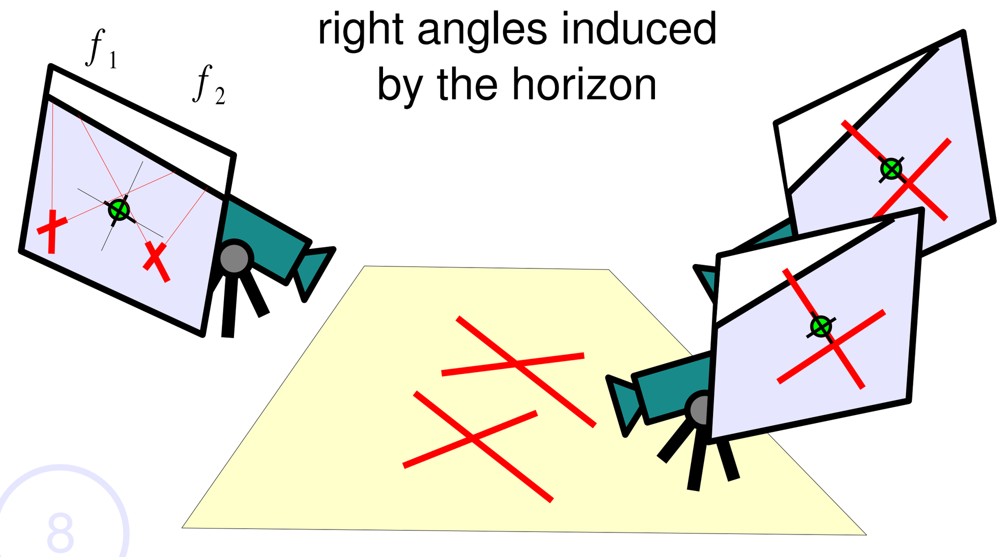
the horizon induces the view of a right angle



$$f = \sqrt{x_1 x_2 - h^2}$$

f can be computed from the horizon and a single right angle

8



right angles induced by the horizon

optimization

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we search for the horizon ***h*** which induces $\boldsymbol{f_1}$ and $C(h,f_1)$ such that all $H_{k,1}C(h,f_1)$ are consistent with camera homographies

variations of the algorithm

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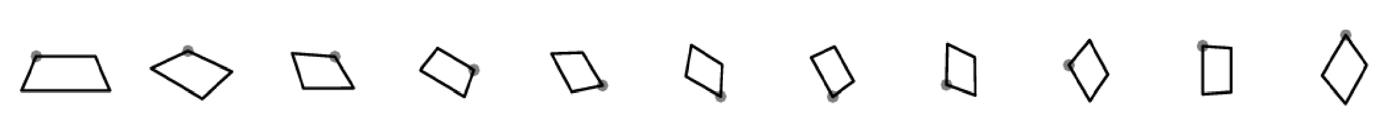
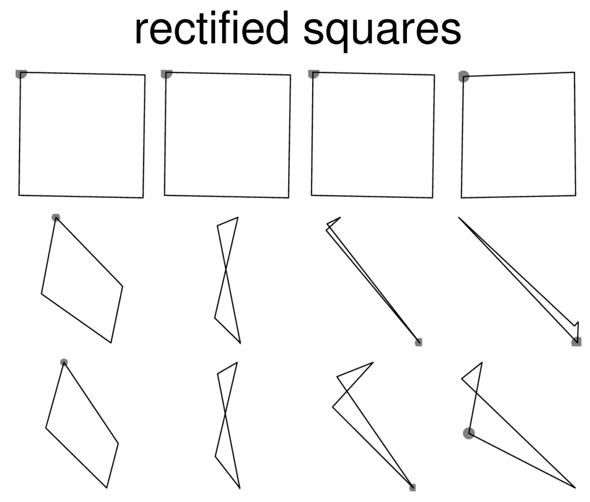
- all f_k known (easy and fast)
- f_1 known (easy and quite fast)
- constant *f* (not so easy)
- all f_k unknown (harder)

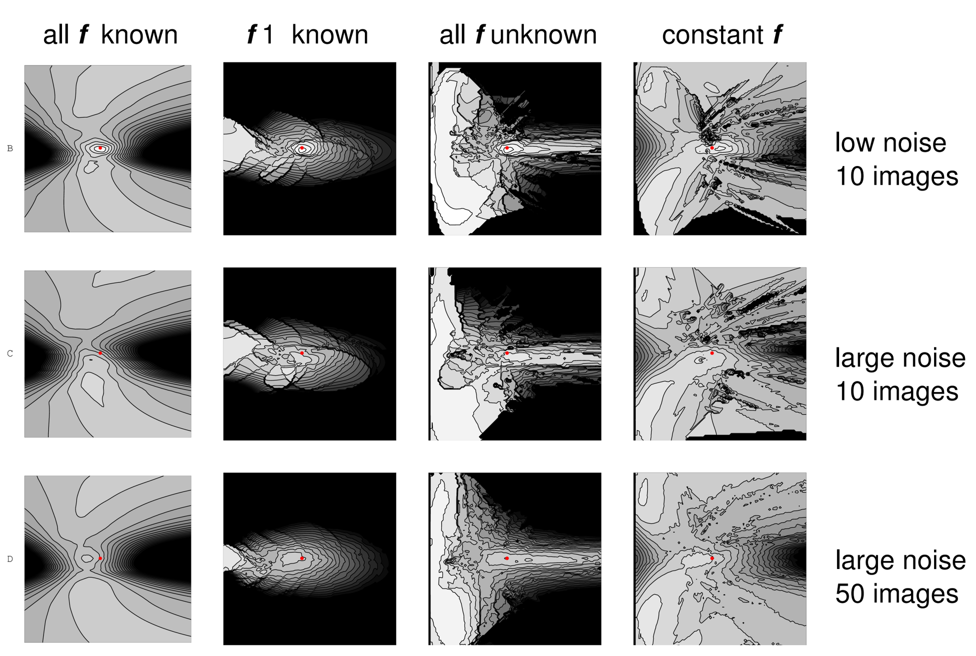
stability

general sequence



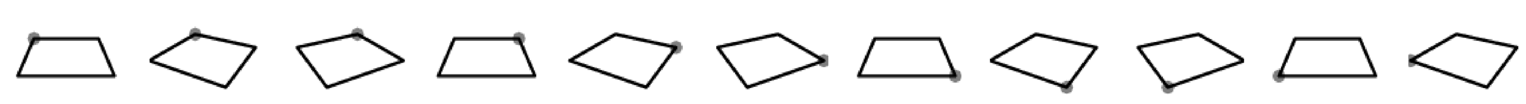
rectified squares



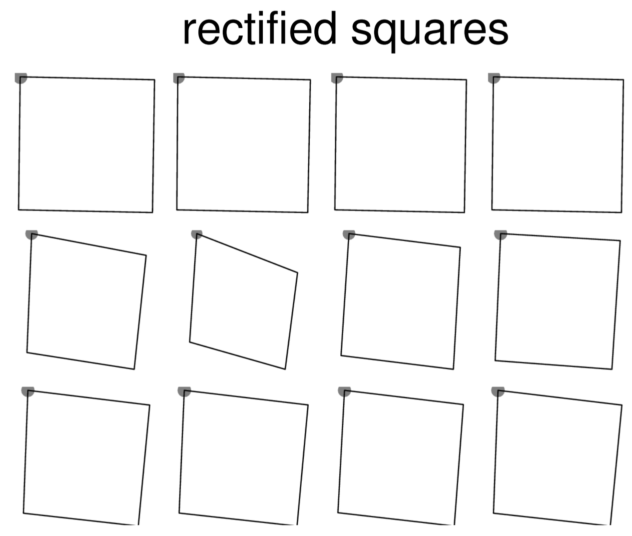


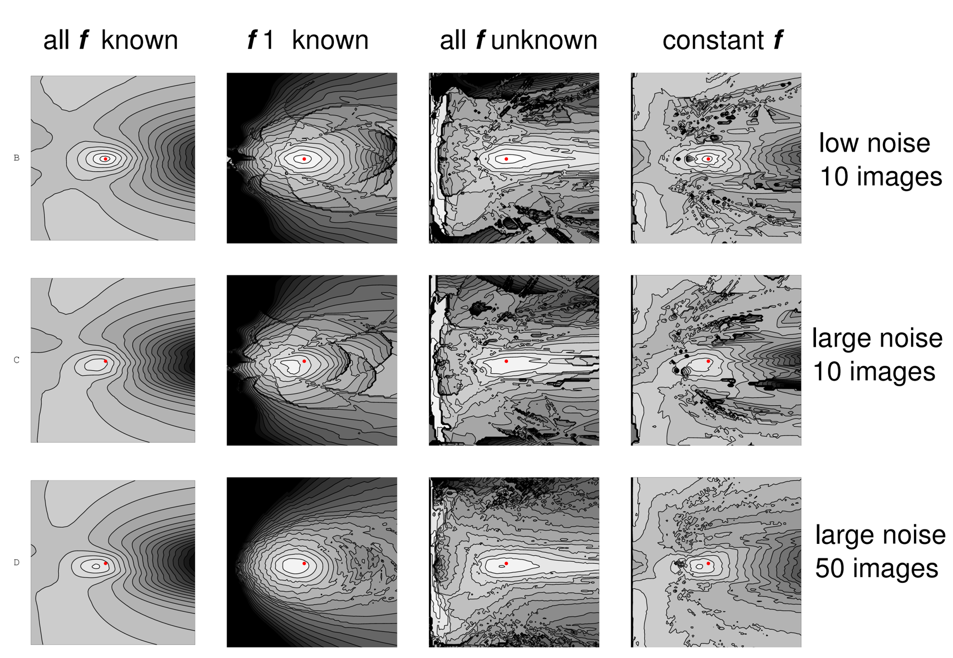
error surfaces

orbit sequence (constant ***f***)



rectified squares



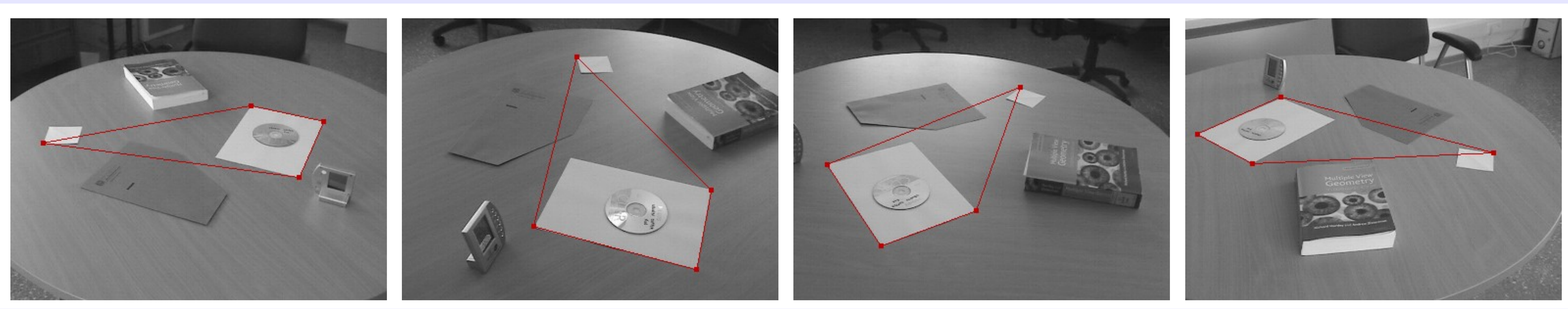


error surfaces

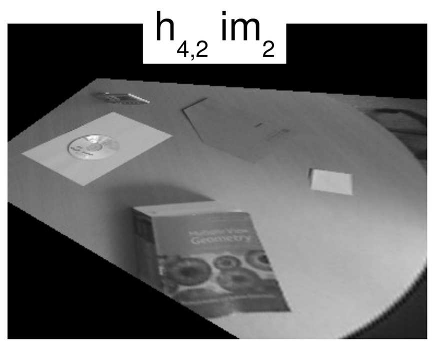
example

image sequence

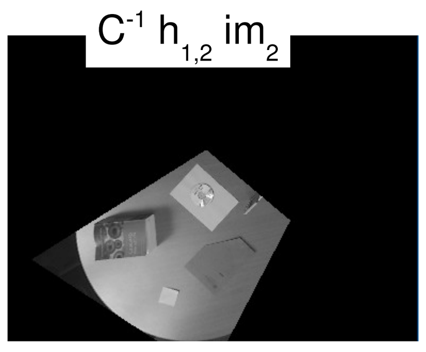
constant known ***f*** = 2.8



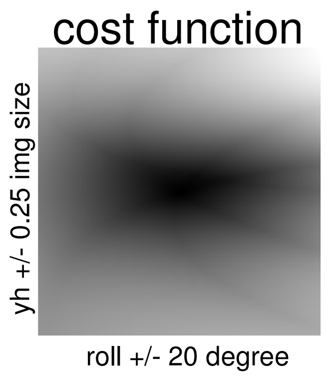
$h_{4,2}$ im_2



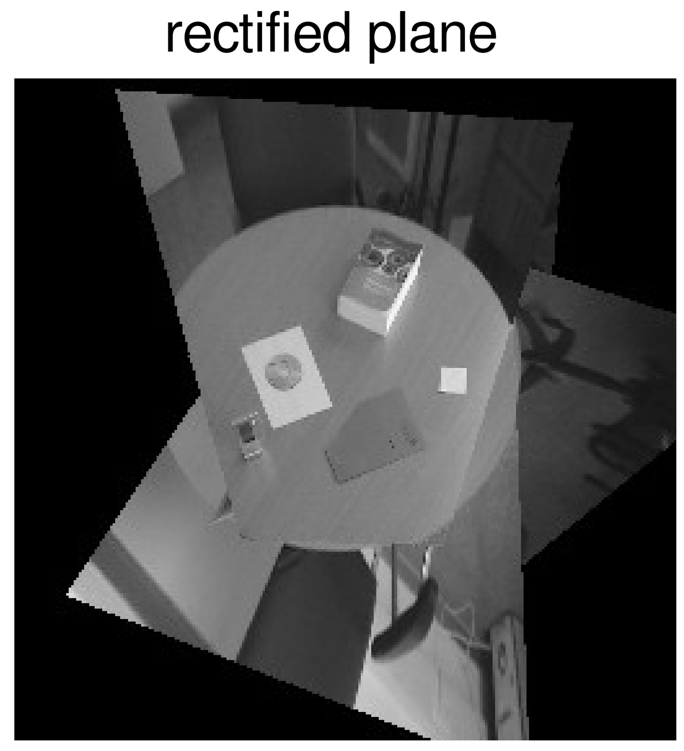
C^{-1} $h_{1,2}$ im_2



cost function



rectified plane



camera pose