Linear 3-D Object Pose Estimation with Dense Sample images

Discussions about Limitation of Parameter Estimation Ability by the Linear Regressions

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What's the LINEAR relation ?

$$p_i = \Omega^T x_i$$

matrix — parameter — image

N-D vector
n samples

if n < N ...

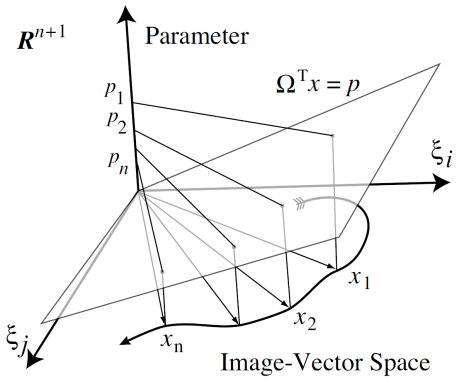
possible!

Linear regression can do!

$$\Omega = X(X^T X)^{-1} P$$

But, impossible for large n !

It needs memory of GBytes to store



The proposed Iterative Algorithm

Initial

$$u_1 = \frac{1}{|x_1|} x_1 \qquad \Omega_1 = \frac{p_1}{|x_1|} u_1$$

Iteration

$$u_i = \frac{1}{|u_i'|} u_i' \qquad u_i' = x_i - \sum_{j=1}^{i-1} (u_j^T x_i) u_j \qquad \Omega_i = \Omega_{i-1} + \frac{1}{u_i^T x_i} (p_i - \Omega_{i-1}^T x_i) u_i$$

n>18,000 samples can be learned!

Recognition and pose estimation

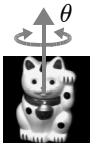
Recognition

$$obj = {\Omega_{obj}}^T x$$

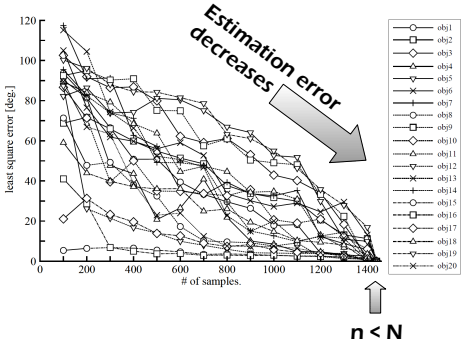
Pose estimation (1DOF)

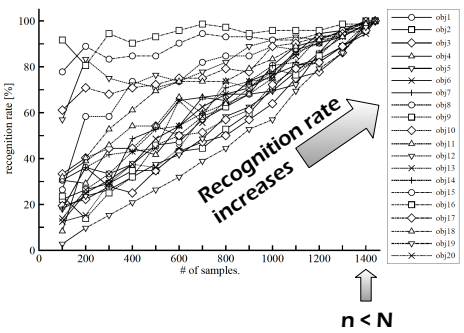
$$\cos(\theta) = {\Omega_c}^T x$$

$$\sin(\theta) = {\Omega_s}^T x$$



N = 128x128 pix = 16,384 dimension
n = 1,444 samples : all of the objects in COIL-20





Object-specific 2DOF Pose Estimation

1DOF rotation

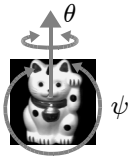
$$\cos(\theta) = \Omega_c^{\theta T} x$$

$$\sin(\theta) = \Omega_s^{\theta T} x$$

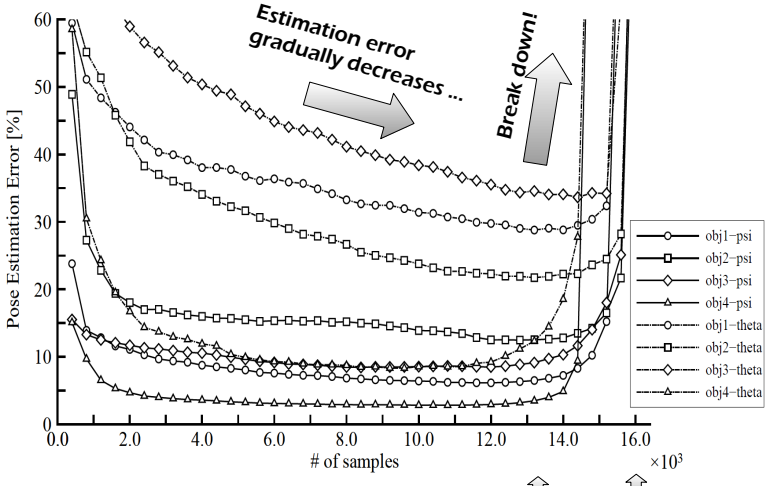
1DOF rotation

$$\cos(\psi) = \Omega_c^{\psi T} x$$

$$\sin(\psi) = \Omega_s^{\psi T} x$$



N = 128x128 pix = 16,384 dimension
n = up to 18,360 samples for EACH object in COIL-20



Linear estimation works if...

Number of samples n ≤ min (Vector dimension N , Number of valid pixels)

Number of valid pixels!

What happens?

n = N