Maximum likelihood approach to the problem of simultaneous contouring and tracking

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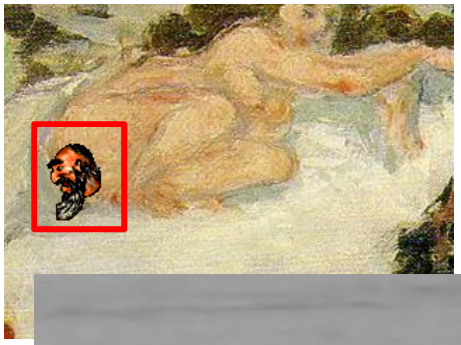
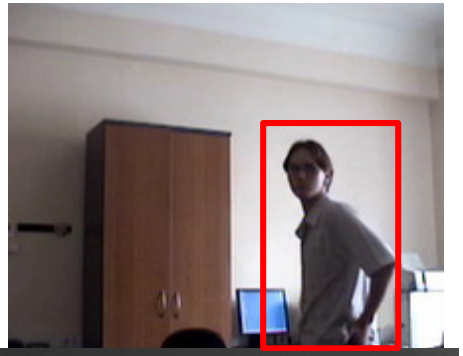
Problem Statement





SOLUTION PRINCIPLES

Global criteria*

Bayesian solution (minimum of mean risk)

Adaptive Bayesian solution

Minimax approach

Maximum likelihood method

* Repin, V.G. and Tartakovsky, G.P. (1978). Statistical Synthesis Under Prior Uncertainty and Adaptation of Information Systems, Sovetskoe Radio, Moscow (In Russian)

LIKELIHOOD FUNCTION

Likelihood function

$$J(I) = \prod_{i \in I} p(i \in object) \prod_{i \notin I} p(i \notin object)$$

Residual functions

for part $\tilde{C}_i(\delta x, \delta y) = \sum_{l,k \in P_i} \left(f_t(l,k) - f_{t-1}(l - \delta x, k - \delta y) \right)^2$

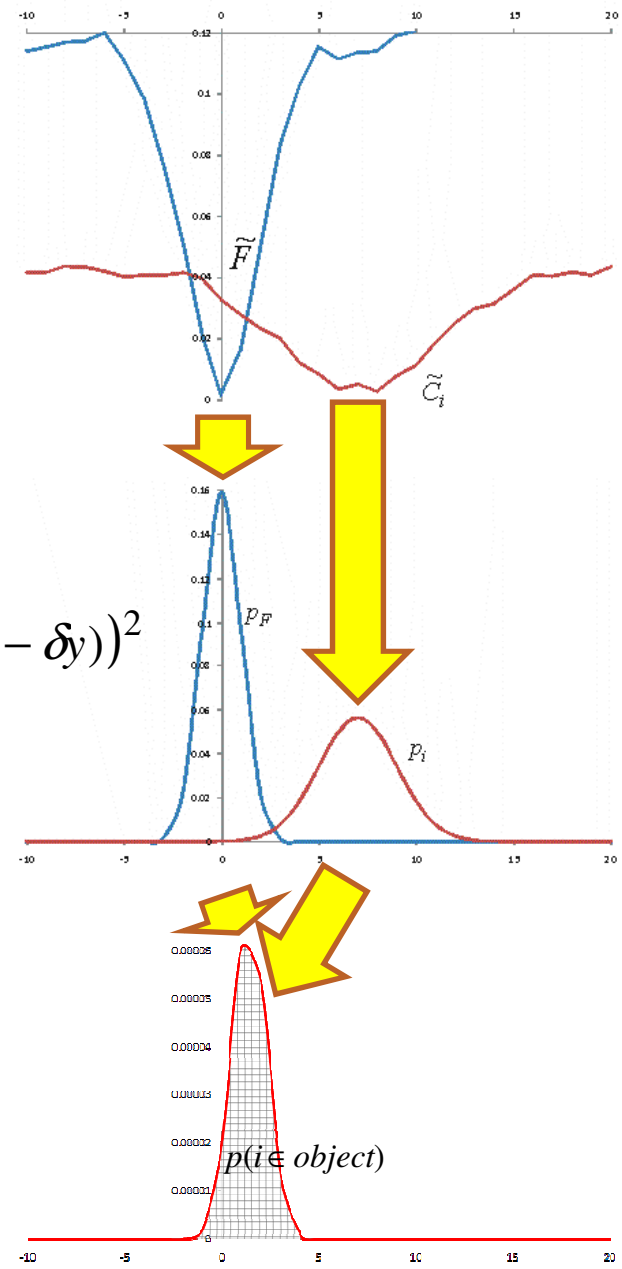
for object $\tilde{F}(\delta x, \delta y) = \sum_{i \in I} \tilde{C}_i(\delta x, \delta y)$

Distribution of true shift of part

$$p_i(\delta x, \delta y) = \frac{1}{2\pi\sqrt{\det(\Gamma_i)}} e^{-\frac{1}{2}(\vec{x} - \vec{x}_i)^T \Gamma_i^{-1} (\vec{x} - \vec{x}_i)}$$

Probability of part belongs to object

$$p(i \in object) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} p_i(\delta x, \delta y)\, p_F(\delta x, \delta y)\, d\delta x d\delta y$$



LIKELIHOOD MAXIMIZATION

Contour $I = \arg\max_{I} J(I)$

Shift $(\delta\tilde{x}, \delta\tilde{y}) = \arg\min_{(\delta x, \delta y)} \tilde{F}(I)$

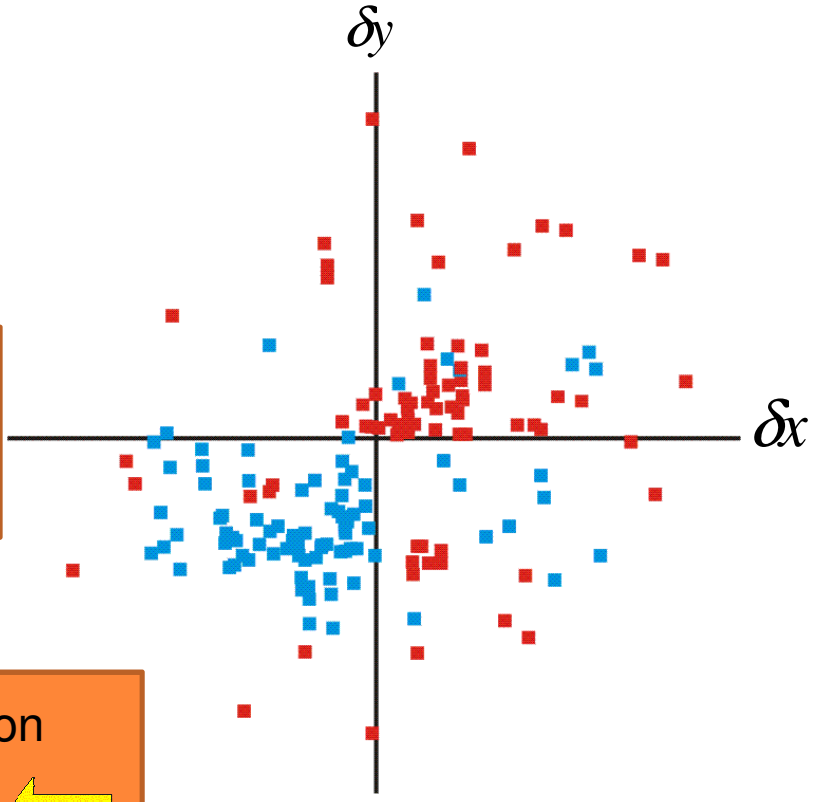
K-Means method
Initial object/background classification

I

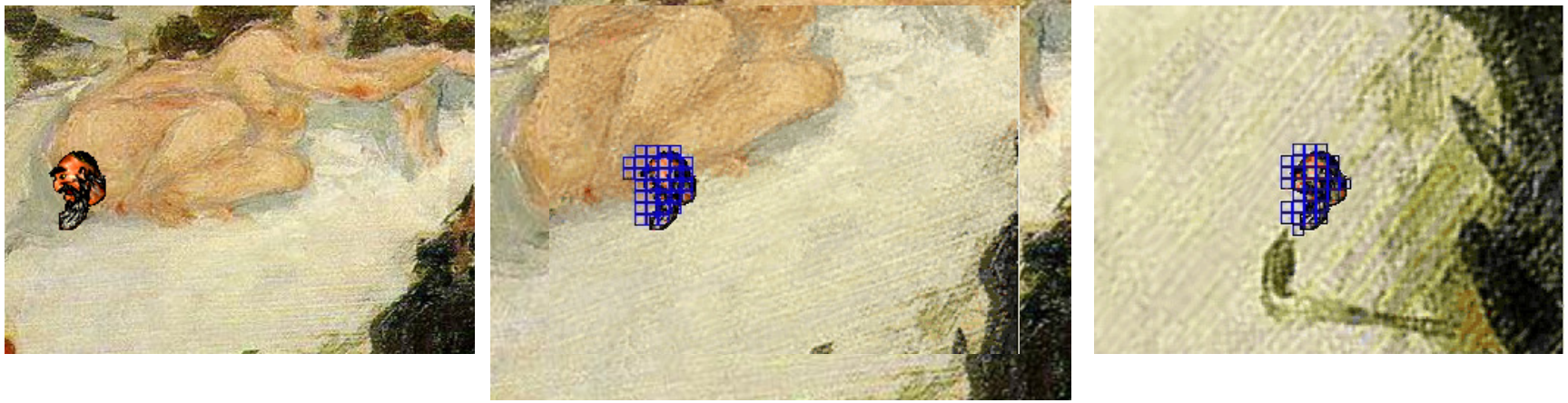
Iterative likelihood based specification

Calculation of $\tilde{F}$

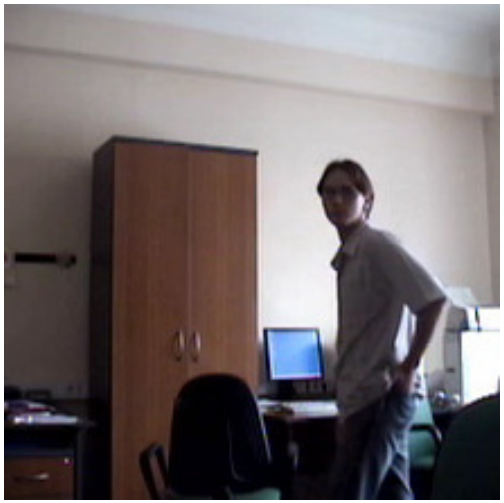
For each i with fixed $\tilde{F}$
$i \in I$ if $p(i \in object) > p(i \notin object)$

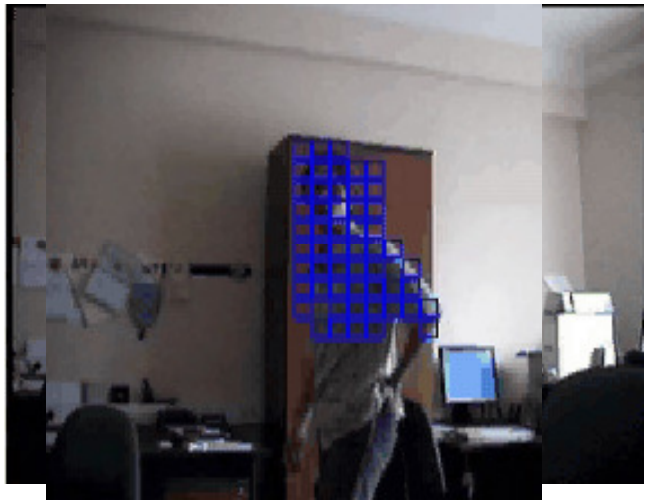


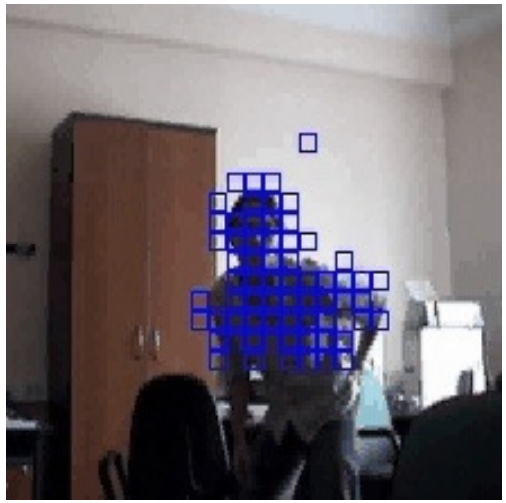
EXAMPLE RESULT



EXAMPLE RESULT







EXAMPLE RESULT

SUMMARY

The method of solution the problem of simultaneous contouring and tracking in case of significantly unstable background and absence of information about size and form of object is proposed.

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