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Motivation
Outline of the talk

How the original CCD

works?

Related work

Improvements of the original algorithm

The CCD tracker

Results of the experiments

Implementation of Contracting Curve Density Algorithm for Applications in Personal Robotics

April 26, 2011

Shulei Zhu Institut für Informatik Technische Universität München

Shulei Zhu



Motivation

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Motivation

Some challenging task in personal robotics

- Image segmentation
- Pose estimation
- Object recognition and tracking
- Model-based methods: these problems require much information external to the image
- Curve-fitting process: a crucial part of these problems

Requirements

- Robustness: stable in texture, clutter, poor contrast environment
- Accuracy: high sub-pixel accuracy
- Efficiency: time-constrained, limited computer hardware resources in personal robotics

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How the original CCD works?

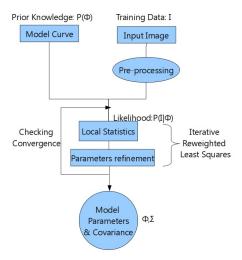


Figure: the CCD algorithm

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Sketch of the CCD algorithm

Basic steps of the CCD algorithm

- Contour initialization
- Learning of local statistics
- Refinement of model parameters



Figure: The contour of a pan

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An alternative view of the CCD algorithm

Bayesian logistic regression

• Evaluation of conditional distribution $p(\Phi|\mathbf{I})$

$$p(\Phi|\textbf{I}) \propto \underbrace{p(\textbf{I}|\textbf{m}_{\Phi}, \Sigma_{\Phi})}_{\text{local statistics}} \quad \times \quad \underbrace{p(\Phi)}_{\text{prior distribution}}$$

 Goal: MAP (maximum a posteriori probability) solution of cost function Q(Φ)

$$\mathcal{Q}(\boldsymbol{\Phi}) = \underset{\boldsymbol{\Phi}}{\text{arg\,max}} \, \ln(\textit{p}(\boldsymbol{\Phi}|\boldsymbol{I}))$$

Approach: iterative reweighted least squares (IRLS) e.g. Gaussian Newton method, SVM

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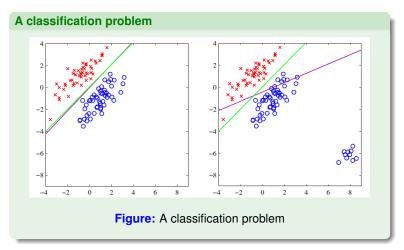
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3-4 papers

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Quadratic and Cubic B-spline curves

B-spline curves

$$\mathbf{C}(u) = \sum_{i=0}^{m-n-2} P_i B_{i,n}(u) , u \in [u_n, u_{m-n-1}]$$

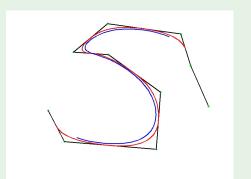


Figure: B-spline curves of degree = 1, 2, 3

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Logitic and Probit function



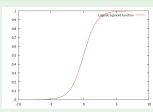


Figure: Logistic function

$$f(\cdot) = \frac{1}{1 + e^{-x}}$$

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Logitic and Probit function

Logistic function

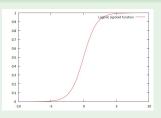


Figure: Logistic function

$$f(\cdot) = \frac{1}{1 + e^{-x}}$$

Probit function

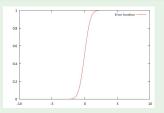


Figure: Probit function

$$f(\cdot) = \frac{1}{2} \left(\frac{1}{\sqrt{2}} erf(x) + 1 \right)$$

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Three-dimensional Affine Shape-space

Parallax effect in two-dimensional affine shape-space



Figure: Parallax effect

Three-dimensional affine shape-space



Figure: Three-dimensional affine shape-space

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Initialization from SIFT Features

Initialization from SIFT Features



Figure: Initialization from SIFT Features

algorithm

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manually initialization

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initialization from SIFT