Implementation of Contracting Curve Density Algorithm for Applications in Personal Robotics

April 26, 2011

Shulei Zhu
Institut für Informatik
Technische Universität München

Outline

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

Outline of the talk

How the original CCD works?

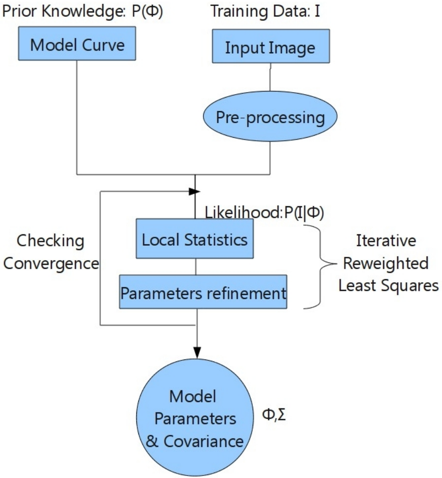

Figure: the CCD algorithm

Sketch of the CCD algorithm

Basic steps of the CCD algorithm

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

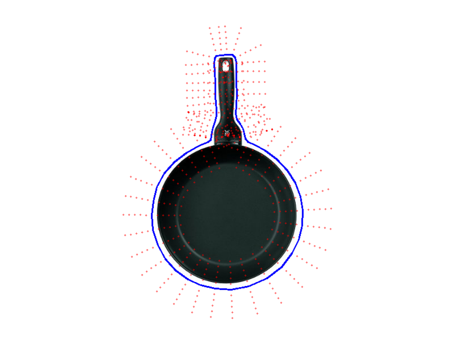

Figure: The contour of a pan

An alternative view of the CCD algorithm

Bayesian logistic regression

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

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

- Goal: MAP (maximum a posteriori probability) solution of cost function $\mathcal{Q}(\Phi)$

$$\mathcal{Q}(\Phi) = \arg\max_{\Phi} \ln(p(\Phi|\mathbf{I}))$$

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

An alternative view of the CCD algorithm

A classification problem

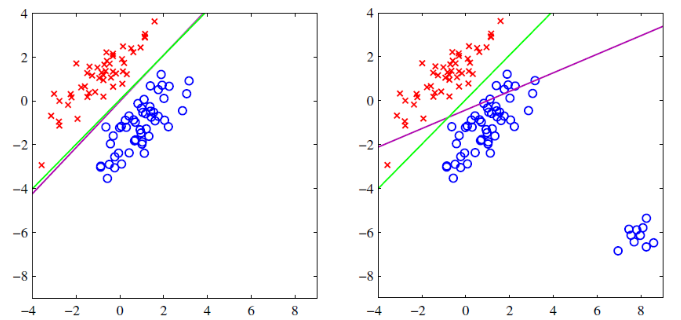

Figure: A classification problem

3-4 papers

Quadratic and Cubic B-spline curves

B-spline curves

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

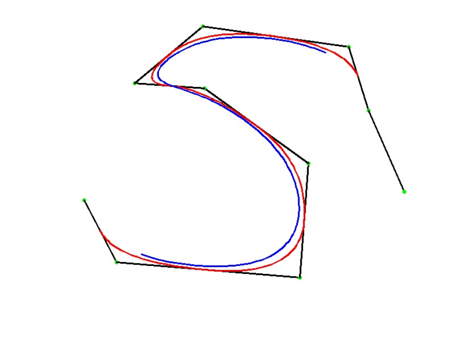

Figure: B-spline curves of degree = 1, 2, 3

Logitic and Probit function

Logistic function

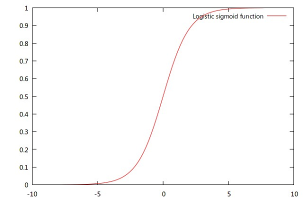

Figure: Logistic function

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

Logitic and Probit function

Logistic function

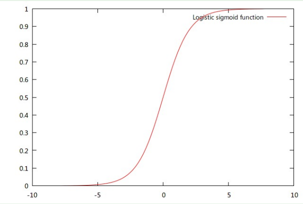

Figure: Logistic function

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

Probit function

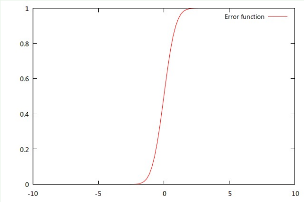

Figure: Probit function

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

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

Initialization from SIFT Features

Initialization from SIFT Features

Figure: Initialization from SIFT Features

algorithm

manually initialization

initialization from SIFT