Daily Thesis-work Report

Javier Fernández

May 10, 2010

1 General topics addressed

- Researching on worm parameterization: the idea is to find a general representation for the worms that can be easily moved, scaled and bent. (I believe that's the shape descriptor)

2 Main per-topic Issues

2.1 Shape descriptions theory

Interesting short briefing of shape descriptors. Lists some common simple descriptors: Area, perimeter, compactness-circularity, Eccentricity, Elongation, rectangularity. **(elongation and rectangularity are interesting)**.
Centered more on region-based descriptors than on boundaries-based ones.
`http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/MORSE/region-props-and-moments.pdf`

2.2 Curve fitting

Curve fitting is the process of constructing a curve, or mathematical function, that has the best fit to a series of data points, possibly subject to constraints.
It adds some nice suggestions:

  - $y = ax^3 + bx^2 + cx + d$ In polynoms to fit curve the degree of the polynom (n) sets the number of *constraints* being fitted. Each constraint can be: a point, an angle, a curvature.
  - **Runge's phenomenon**: high order polynomials can be highly oscillatory

- Spline and Bézier Curves. Tend to avoid Runge's phenomen, unlike polynomial interpolation.
- **Fitting**
  - Algebraic analysis: "fitting" usually means trying to find the curve that minimizes the vertical (i.e. y-axis) displacement of a point from the curve (e.g. ordinary least squares).
  - Graphical and images apps: fitting seeks to provide the best visual fit; which usually means trying to minimize the orthogonal distance to the curve (e.g. total least squares), or to otherwise include both axes of displacement of a point from the curve.

http://en.wikipedia.org/wiki/Curve_fitting

2.3 Contour based shape descriptors

Great link for reading an overview of contour-based shape representation and description.
http://www.engineering.uiowa.edu/~dip/LECTURE/Shape2.html

- **B-Spline:** Seems to be fastly executed. With a n=3 creates a very accurate triangulated countourn

  Interactive splines: ttp://www.ibiblio.org/e-notes/Splines/Intro.htm **Cardinal Splines:** They pass smoothly by every point selected.

2.4 Triangle mesh in figures, easily bent and deformed

In hd as: *As-rigid-as-possible.pdf* Web link: http://portal.acm.org/citation.cfm?id=1073204.1073323

Shape manipulation techniques fall roughly into two categories. One is to deform the space in which the target shape is embedded; the other is to *deform the shape while taking its structure into account.*

Our goal is to introduce internal model rigidity into shape manipulation. However, instead of using physically based models, we use simple geometric approach similar to a technique used in [Alexa et al. 2000].

The Process

- Silhouette tracing with marching squares algorithm
- Generates a triangulated mesh inside the boundary. Better manipulation results achieved using near-equilateral triangles of similar sizes across the region. They use [Markosian 1999], that starts with a standard constrained Delaunay triangulation, iteratively refining the mesh.
- Resize managing rotation and scale.

2.5 Delaunay Triangulation (mesh creation)

A Delaunay triangulation for a set P of points in the plane is a triangulation $DT(P)$ such that no point in P is inside the circumcircle of any triangle in $DT(P)$. Delaunay triangulations maximize the minimum angle of all the angles of the triangles in the triangulation; they tend to avoid skinny triangles.

For manipulating delaunay triangles http://www.cs.cornell.edu/home/chew/Delaunay05.html

2.6 State of the art in shape matching

Describes several state-of-the-art techinques in shape matching.
http://books.google.com/books?hl=en&lr=&id=2SPuMz-BG-4C&oi=fnd&pg=PA87&dq=shape+matching&ots=Q1qi7dVkhI&sig=ersscZ6x2A73Uw_h77X4NDYu9U#v=onepage&q=shape%20matching&f=false

Interesting briefing on contourn matching techniques: http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/GDALYAHU/gdalyahu.html

2.7 Marching Squares

Contour detection process. Very simple process, can be hard to determine one worm over another.
http://en.wikipedia.org/wiki/Marching_squares http://users.polytech.unice.fr/~lingrand/MarchingCubes/algo.html

2.8 2D Shape deformations

Look in HD: *2D Shape deformation.pdf*

2.9 Free form deformation

Checkout free form *.pdf* on HD.
Also: http://www.docstoc.com/docs/7613261/Accelerating-Accurate-B-spline-Free-form-Deformation-of-Po

2.10 Strategies for automated analysis of C.Elegans

Check the Homonymus .pdf stored in HD.

All automated vision programmes for worms follow a similar processing strategy which usually involves extrac- tion of the worm from the background (segmentation) followed by reduction of the worm to a skeleton

2.11 A trainable method for parametric shape descriptors

Not much nice things. Method for finding parametric shape descriptors, tested un C.Elegans. Does not give anything interesting for the moment. Maybe it will help to completing the paremeterisation.

2.12 Chamfer matching

Interesting distance transform method. Computationally unexpensive, not hard to implement. Requires a well defined set of templates. It will be useful then if the variations over the shape descriptor are enoughly well performed by the optimization algorithm.

2.13 Skeleton matching

About parameterization: The skeleton can be considered mathematically as a function. It can also be represented as polyline (a string of connected straight lines) and the angles between the segments measured.

2.14 Graph matching for object recognition and recovery

The object recognition is realized through shape matching, by matching the skeleton graph of the input contour from a deformable contour method (DCM). Skeleton is used as shape descriptor due to its significant features on the desired representational properties, such as invariance to object geometric transformations (translation, rotation and scaling) and reversibility to the original shape. To the shape description is also given widht and length of each part, and location of convex-parts.

Skeleton structure notation

The skeleton representation is based on the location of the **Centers of maximal disks (CMD)**. A skeleton graph is generated and the segments are recognized and splitted. The different nodes are identified as: *ending node*, *bifurcation node* and *normal nodes*. A segment with two *bifurcation nodes* is as *primary* segment, otherwise is normal.

2.15 A computational model for C. elegans locomotory behavior: On Parameterization

Check at Uppsala

2.16 Genetic contour matching

From genetic contour matching paper in HD.

Keywords: **Object detection; Chamfermetric; Edge transform; Distance transform; Contour model; Contour matching; Genetic algorithms; Optimization**

Object recognition can be formulated as an optimization problem. The objective function measures for instance the evidential support for any particular projection of the parameterized object contour model onto the input image. A genetic algorithm can be used to find a set of parameters which provide an optimal interpretation of the image in terms of the model. Preliminary test results demonstrate the feasibility of the proposed approach.

The contour matching present involves 3 stages:

- Binary representation of the input image is created by thresholding.
- The binary image is transformed into a grey-level image in which all pixels have a value that corresponds to the distance to the nearest edge (object contour) pixel

- A G.A. minimizes an average of the values of the pixels in the distance image that coincide with the projection of an instatiation of a parameterized 2d contour model.

The objective function used in this study is based on the observation that a good match is one where every element of the projected model contour is spatially near an image contour.

Interesting things in defining the shape descriptor and how to define an error difference to minimize. Is presented for star-shapped objects, which the worms contour are not.