Daily Thesis-work Report

Javier Fernández

April 20, 2010

1 General topics addressed

- Combinatorial optimization in image analysis paper review
- Splines: fast and accurate implementation
- Curve fitting / Spline fitting techiques

2 Combinatorial Optimization in image analysis

Rally nice explanation on topics like **local search, simulated annealing, genetic algorithms**

GA and SA

Big reference to *An integrated genetic algorithm* which envolves several adds to make it more powerful than a simple genetic algorithm. Is mentioned the importance in having a rich pool of solutions in a simple genetic algorithm, they rely on it. The convergence of the GA improved considerably after the incorporation of a knowledge based mutation operator and meta-level genetic operators (took the same time to generate a new generation that one iteration of SA). As usual local search is 15 times faster, finds acceptable solutions but the minimun of the cost function is higher so the quality of solutions is lower.

Image Segmentation

Image segmentation is a clustering procedure applied to a matrix representation of the image. It typically partitions the spatial domain of an image into mutually exclusive subsets, called regions. Each region is uniform and homogeneous with respect to some property such as tone or texture, and its property value differs in some significant way from the property value of each neigbouring region. The segmentation of an image into meaningful parts is a key step in nearly every image analysis problem. It is crucial to the successful identification of the depicted targets, and to the accuracy of target analysis such as shape and area.

Target Recognition

Model-based target recognition involves the detection and classification of instantiations of predetermined patterns or target models in an image. This involves the estimation of the parameters of a model -to- image transformation that results in the observed image

Contour Matching

Optimization of a distance matching function that measures the distance of the image shape to a set of predefined shapes or template contour.

Algorithms involved SA, GA and Markov Random filed polar model.

GA Approach

Generating a pool of random templates all around the image to avoid local minima. In this scheme the size and shape of the model contour adapt to the local image evidence.

2.1 Important concluding remarks

- Of all modern optimization techniques, simulated annealing is most frequently applied to solve large combinatorial problems in image analysis. It produces good quality solutions, but converges rather slowly
- Genetic algorithms produce good quality solutions when the population size fully repre- sents the diversity of the underlying search space. They converge faster when the local search (mutation) procedure is constrained by a priori knowledge of the image structure (Bhandarkar et al., 1994).
- Local search generally yields the fastest rate of convergence, but also produces the lowest quality solutions because the algorithms easily get trapped in local minima
- Mean field annealing is considerably more efficient than simulated annealing, and produces nearly the same quality of the final solution

2.2 Finding contour in 1-worm WormCluster

The contour was found selecting one contour pixel and following the 1-distance-pixel contour recursively until no more are found.
To find efficiently the initial pixel a base pixel is selected. If this is contour is the initial pixel, if not then the 8-neighborhood is checked. If no one of this is contour then the one with fewest distance value is selected and the directional pixels are analized. This has to ensure to find a contour pixel given the worms cilindrical and not that wide shape.

2.2.1 Many worms Cluster

The actual implementation is located in the *Thickening* class and is aimed to rebuild the shape iteratively. This is starting from the skeleton points and with the highest distance value and iteratively add the new neighbors that belong to the shape to the list. The pixels are accepted as part

of the shape if they have the same current distance value when analized.

Not very impressive results. The shape is quite covered, but there are great cut-outs.

2.3 Splines

Great link for many Java applets. Gotta check if the source code for cardinal spline is usable. It seems to work really well. `http://www.netgraphics.sk/cardinal-spline`

Seems to implement cardinal splines: `http://prefuse.org/doc/api/prefuse/util/GraphicsLib.html`. it's called **Prefuse** and information visualization toolkit. Seems interesting and useful. BSD license by the way.