Active contour on the basis of inertia

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POSTER ABSTRACT

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ABSTRACT

This paper present a method for image segmentation, which is an adaptation of the classical active contours algorithm, also called “snakes”, using a new internal energy approach. The classical model computes the energy function based on changes in gradient values, thus determining the detection of the object’s edges. In the proposed model, the active contour moves attracted or repelled by its mass center, thus keeping the inertia towards shape compression or expansion. This represents an intuitive, simple and efficient scheme that constitutes an alternative to classical segmentation methods.

Categories and Subject Descriptors

I.4.6 [**Image Processing and Computer Vision**]: Segmentation – *Edge and feature detection;* I.3.5 [**Computer Graphics**]: Computational Geometry and Object Modeling - *Curve, surface, solid, and object representations*.

General Terms

Algorithms, Measurement, Design, Experimentation.

Keywords

Image Processing, Active contours, Snakes, Medical Imaging, Inertia, Centroid and Pseudocentroid.

1. INTRODUCTION

The active contour concept was introduced by Kass, Witkins and Terzopoulos in order to represent images’ contours in Proceeding of the First International Conference on Computer Vision in 1987. The original model [1] employed a function energy divided into three different energies: inner energy, image energy and external restriction’s energy.

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The greedy algorithm presented by Williams and Shah [2], which uses the inner and external energy, has been taken as a reference.

In this model, firstly, the inner energy of Williams and Shah model is replaced by an inertia strength, which is determined by the “snake’s center mass”, i.e. the centroid, although it can also be used in other approximations and, secondly, the external energy does not present any change compared to the traditional one, the Williams and Shah model.

2. ENERGY FUNCTION

The energy function of the snake is defined as an inertial energy and an external energy. We are going to explain in detail what each of them consist in, and how they have been implemented in this model. The inertial energy does not take part in the function of energy as itself, but it is associated with every node of the active contour, that is, each point of the snake has a determined inertial strength depending on the position it has. In order to calculate this relative position, the snake’s centroid is used. Each point of control, thanks to is associated inertia, will tend to approach or to move away from this centroid.

In order to calculate the direction of the inertia strength, different considerations can be made: eight directions or only four, depending if the snake can contract or expand itself. These directions will be symmetrical.

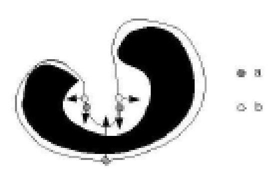

Figure 1. a: current wrong behaviour of the snake; b: Desired behaviour in this zone.

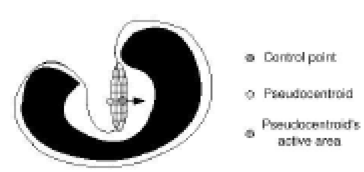

Figure 2. Pseudocentroid use for correcting the path of the snake.

The external energy is calculated by using some function gradient, which must be carefully chosen depending on the sort of images we wish to work on.

Therefore, the energy function will have minimum values in those zones of high gradient, which are the zones where the borders will be possibly located.

3. PSEUDOCODE OF THE NEW ALGORITHM

Some changes have been made on the greedy algorithm:

```
do
  for i=0 to n   //Applying inertial movement
    Emin=MAX ENERGY
    for j=0 to m-1    //Looking for minimun energy's neighbour
      if Ej<Emin then
         Emin=Ej
         jmin=j
      if Egradient<APPROACH EDGE then
        Switch the inertia off
    if jmin<Actual position then
       Moved points = Moved points + 1
    else //Use inertia if it is activated AND there is no point
         //with less energy
      if Inertia is on then
        Move point by using inertia
until Moved points < Threshold
```

- n is the number of points of the snake
- m is the number of neighbours
- MAX ENERGY is the maximum value of the total energy
- Moved points are the nodes that have moved
- APPROACH EDGE indicates the energy limit value
- Threshold is the contour's level of activity, usually [2..5]

There are some terms in this pseudocode such as, "switch inertia off" and "move point by using inertia" that, as their names themselves say, are procedures that cancel the inertia of a particular point by setting the right variables and moving one point taking into account the inertia associated to it.

4. PROBLEMS OF FIRST PROVIDED SOLUTION

The model which has been introduced is simple and efficient when the figures do not present high values of curvature, that is to say, those figures in which do not exits zones very concave or convex. In this kind of figures, the strength of inertia does not lead the snake to the border. So, it is necessary to make a new mechanism that changes the direction of the movement of the active contour toward the border of the object in order to recognize it.

In this new model, a pseudocentroid is used in order to correct this fault. It consist of a centroid of the affected zone moved towards a closer place to the border of the desired contour. The pseudocentroid gets the snake to go to the edge. The fact that the pseudocentroid is calculated only taking into account the affected points is very important.

5. EXPERIMENTAL RESULTS

In order to prove that this method works successfully, a group of tests have been developed. These tests have been used to compare the inertial snake's behaviour with the traditional model. The comparision of classical method and the proposed one has been studied as a multicriteria decision problem.

6. A MULTICRITERIA DECISION PROBLEM

We compare our proposal with the classical method of snakes [1] under a Multiple criteria decision-making (MCDM) framework. This is really a multicriteria decision-making problem, because we have a set of alternatives (the two methods under study) and a set of criteria, i.e. information representing the decision-maker's preferences according to different point of views. Specifically the set of criteria consists of some region's moment-based features.

Our goal is to identify the best method. We consider the CT image feature value profile as the ideal profile of features values. Thus we identify every one of these values with perfection, and we denote it by 1, so all the ideal profile values are 1. Decision matrix is transformed proportionally.

We have also used a distance-based method: Compromise Programming (CP) [3] which proposes as the best solution the one which is a the least distance from an ideal point.

Experiments were conducted over a collection of 32 images. The distance function used by CP depends on one parameter. We have considered three values for the parameter: 1, 2 and 30. The three MCDM methods find the same strategy as the best: inertial snake.

7. CONCLUSIONS

The new method suggested in order to make the segmentation of medical images gives some advantages about other extant methods. On the one hand, the simplicity of the model: the active contour tends to expand ot contract itself if it does not find the border of an object in its way; moreover, in this model do not exist too much parameters which make the configuration of the snake tedious, as in many other snakes algorithms.

The comparision of classical method and the proposed one has been studied as a multicriteria decision problem. We have used three Multiple criteria decision-making methods to compare several snakes algorithms. The three methods found the same strategy as the best: inertial snake.

8. REFERENCES

[1] Kass, M., Witkins, A. and Terzopoulos, D. (1998) Snakes: Active contour models. *Int. J. Comput. Vision*. 1:321-331.

[2] Williams, D. and Shah, M. A fast Algorithm for Active Contours and Curvature Estimation. CVGIP: Image Understanding, Vol. 55, Nº1, pp.14-26, Enero, 1992.

[3] Zeleny, M. (1982) *Multiple Criteria Decision Making*. McGraw-Hill, New York, NY.