Homework3 for Mathmatical Image Process

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1 Level Set Method

First we take a look at the garden flow of the Geodesic active contours model $J(c) = 2\sqrt{\lambda}\int_a^b g(\nabla I(c(q)))|c'(q)|dq$(where $g(x) = \frac{1}{x^2+1}$) where can be shown as follow:

$$\frac{\partial c}{\partial t} = (\kappa g - < \nabla g, N >)N$$

Fig1. The origin picture I and the value of $g(|\nabla I|)$

In order to let the curve cling to the edge we may add another force to push the curve into the concave part of our object, then our gradient flow turns into:

$$\frac{\partial c}{\partial t} = (\kappa g - < \nabla g, N > +\alpha g)N$$

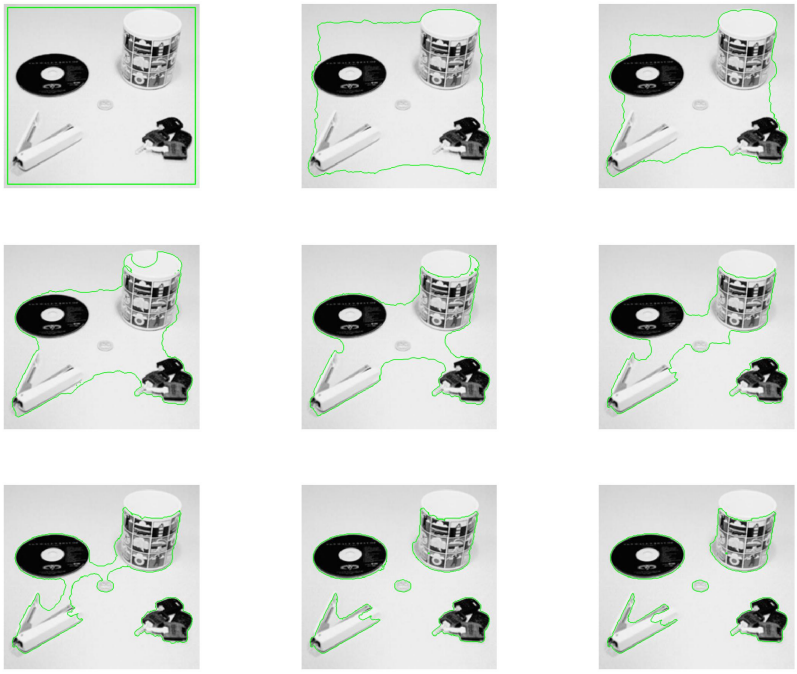
Now we consider the curve as the level set of a function u, then $N = -\frac{\nabla u}{|\nabla u|}$, the above gradient flow can turns into

$$\frac{\partial u}{\partial t} = g(|\nabla I|)(div(\frac{\nabla u}{|\nabla u|}) + \alpha)|\nabla u| + < \nabla g, \nabla u > \tag{1}$$

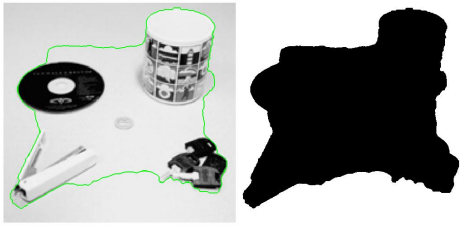
2 Numerical Result

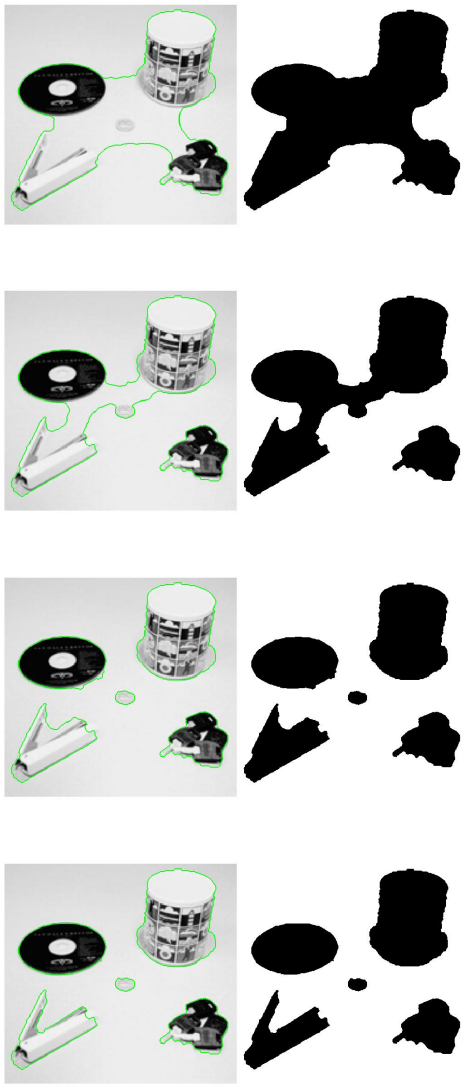
2.1 The evolution of the curve

We use central difference and upwind discretization to discretize the equation (1)



Test1. The evolution of the curve use level set method





Test1. The evolution of the curve use level set method

The force to shrink is bigger than the force to cling to the edge, so we loss some of our cup.

2.2 Problems

2.2.1 Local Minimal

The result of Prof Zaiwen Wen's picture at iterate time 6000,7000,8000 is shown below. It seems that our curve stops at the local minimal

This test alerts us that if use apply the level set method to complicated vision tasks we should do some improvements to avoid the local minimal.

Test2. The curve stops at the local minimal.

2.2.2 The choice of function g

We can add a parameter to the function g, set it as $\frac{1}{1+kx^2}$, for different k the result may displays different

Fig2. Different choices of parameter k

Different k may change the converge rate:

Test3. Different choices of parameter $k = 2$(first row,iterate time:500,1000),$k = 0.01$(second row,iterate time:500,1000)

Different k may also change the result, change the k and the local minimal may disappear

Text4. Turns $k = 0.01$, level set method can get the position of Prof. ZaiwenWen

From my points of view, the week point of level set method is that **too much parameters and the choice of the parameters depends on different pictures.**

3 Appendix

3.1 Readme of my code

The entrance of my program is **main.m** and the **levelest.m** is the function to apply levelest method, the function **showlev.m** turns the function u to its levelest curve.