ECE 6310 – INTRODUCTION TO COMPUTER VISION

Final Project

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Objective:

In the Final Project for this course, we had to develop a GUI upon the previous GUI which we had developed in the Lab 4 and combine it with Active Contouring done in the Lab 5. In addition to the Lab 5 we had to implement balloon phenomenon of active contouring which we had not implemented earlier as well as we had to implement manually moving of a single point functionality to the contouring.

Implementation:

For this project we must load a .pnm file and once it is loaded, we have to draw either shrinking contour or balloon contour and then perform the contouring in the GUI. With the left click of the mouse the user should be able to draw the shrinking contour initial points and down sample them down to every 5^{th} point from all the points drawn and when the user uses right click the ballooning contour is initialized and the ballooning contour is performed. And lastly, we had to implement where holding the shift button we should be able to move a single contour point and it should not affect the rest of the points during that time.

Shrinking:

Once the initial contour is drawn using the left click of the mouse the shrinking model is implemented. The internal energy causes the contour to shrink. Pixels are searched in the 19x19 window and energies for every pixel is counted the contour point tries to move in the direction where the energy is the least. The internal energy is not dependent on the image data it is based on the location of the other contour points and the external energy is based on the image data. I have used 2 internal energies and 1 external energy.

$$E = 4 * Einternal1 + 7 * Einternal2 - 2 * Eexternal1$$

Ballooning:

When the user uses the right click of the mouse and clicks once in the image at a location from that location a radius of 10 pixels is created of the initial contour points. The internal energy should cause the balloon model to expand. The new location of the pixels is looked in the 23x23 window, 2 internal energies and 3 external energies are used. The internal energy which is the square of the distance between the points should be negative to let the contour expand.

$$E = 2 * Einternal1 + 1.5 * Einternal2 - (1.1 \text{ or } 1.3) * Eexternal1 + 1.2 * Eexternal2 + Eexternal3$$

Neutral State:

In this mode no shrinking or ballooning takes place in this mode the user can grab a single contour point and move to a particular place to make the contouring perfect. In this model there are only 2 energies. The internal energy term is the square of deviation from the average distance between points and the external energy term is the square of the image gradient magnitude. The idea here is to relocate the contour points evenly, so the internal energy will be weighted more heavily. This works fine with grabbing a point towards an actual contour of foods. However, when grabbing out a point which lies on the actual contour, some other points will follow that point to be out of actual contour after several iterations. To make all the points to try to stay on the right path, the weight of internal energy will be set to zero after 10 iterations and let external energy to pull points back. The total energy is calculated as:

$$E = (2 \text{ or } 0) * \text{Einternal2} - \text{Eexternal1}$$

Results:

Shrinking:

Figure 1 Fish initial contour

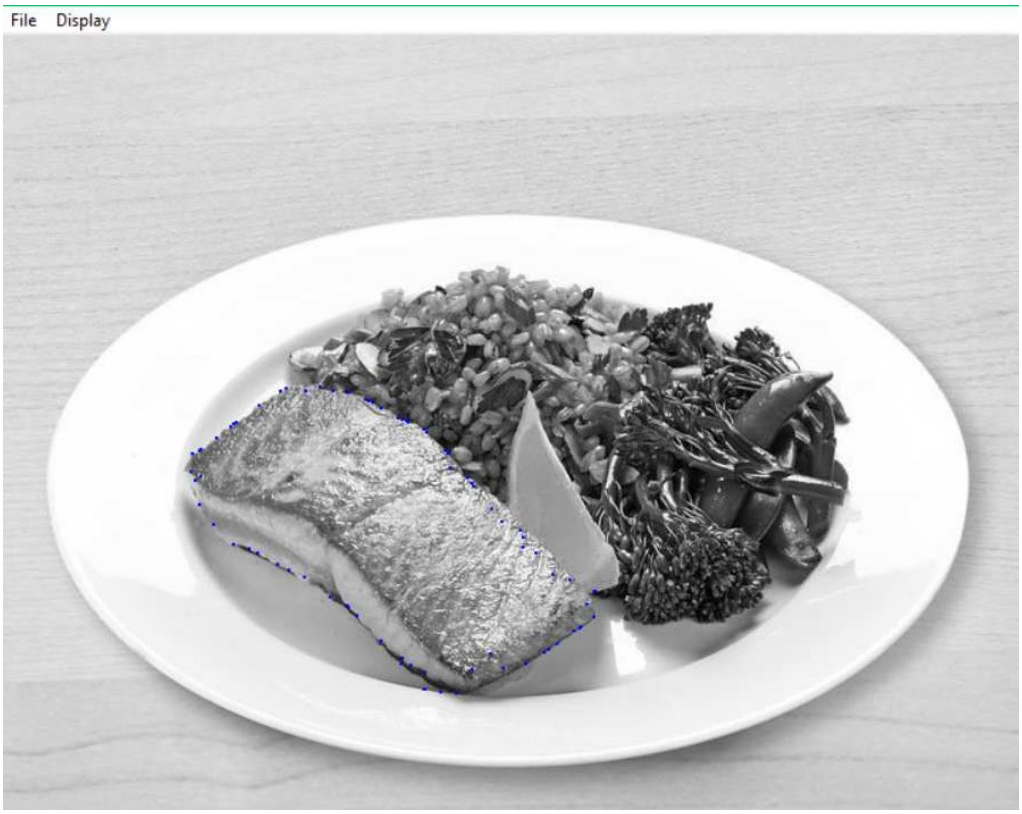

Figure 2 Fish Final Contour

Figure 3 Milk shrinking contour

Figure 4 Hushpuppies shrinking contour

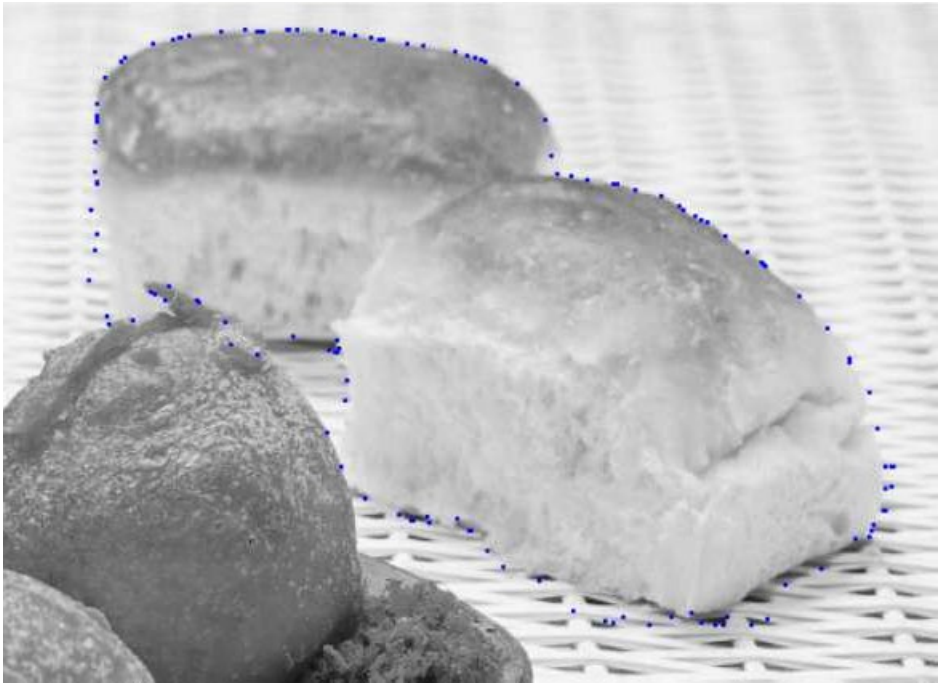

Figure 5 Biscuit shrinking contour

Figure 6 Kale shrinking contour

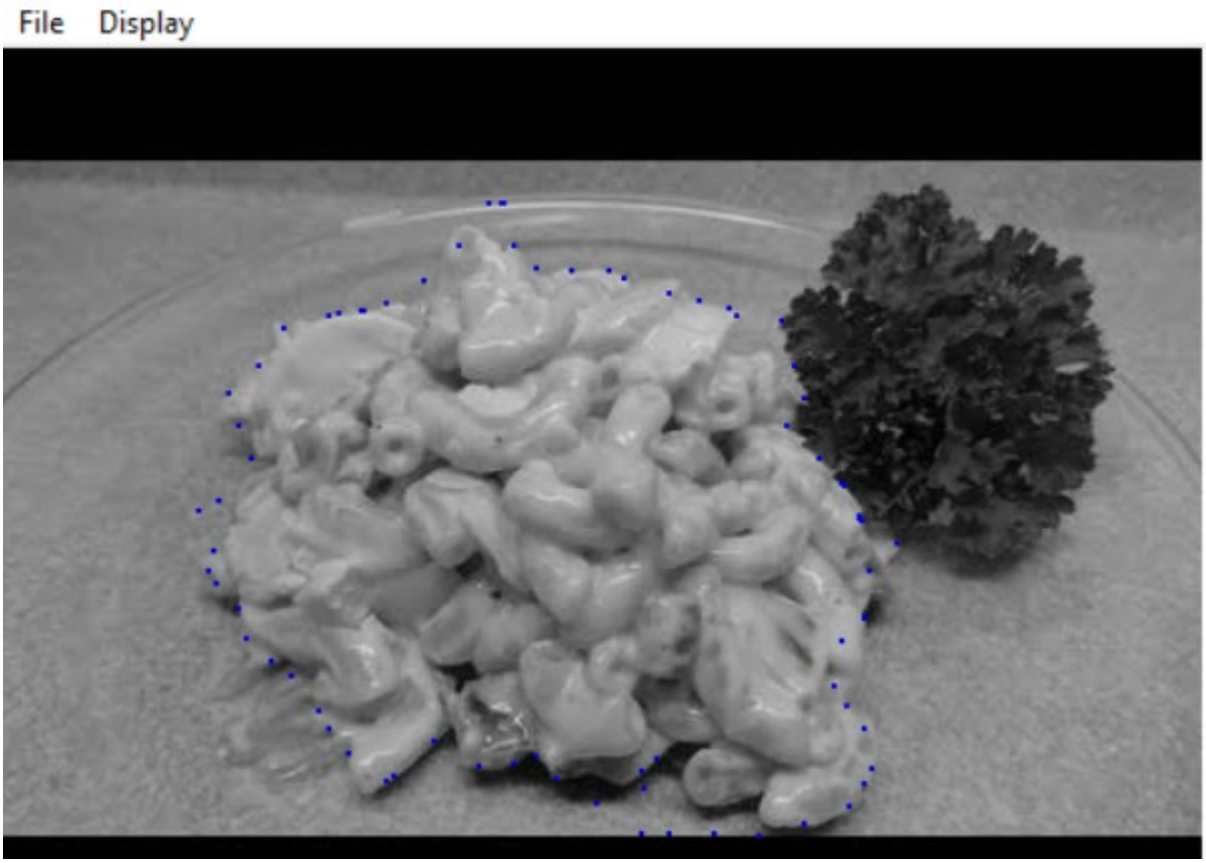

Figure 7 Macaroni shrinking contour

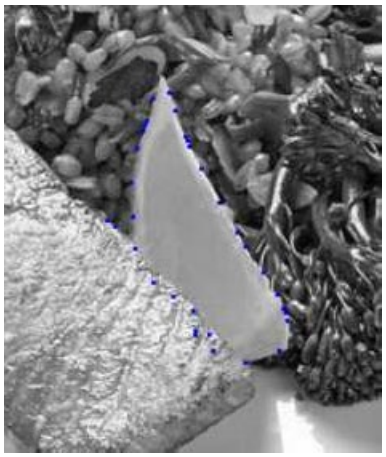

Figure 8 Lemon shrinking contour

Balloon:

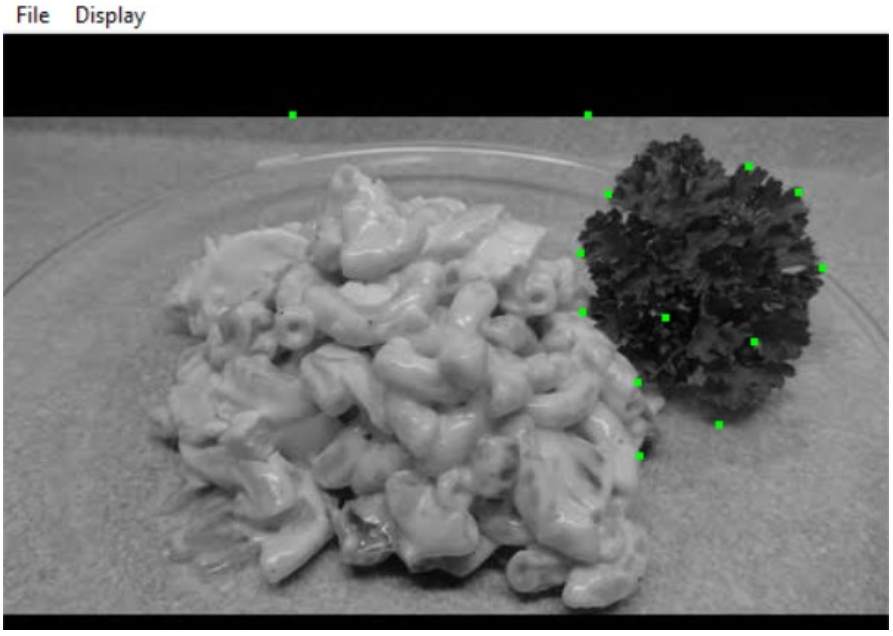

Figure 9 Kale balloon contour initial

Figure 10 Kale balloon contour after moving some points

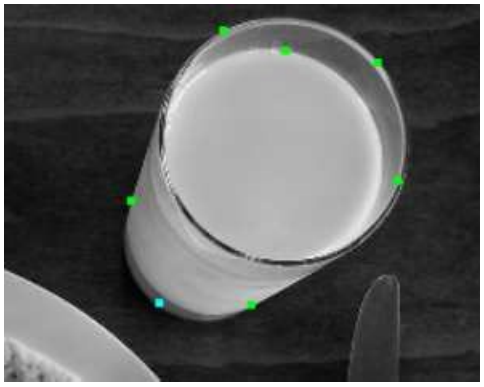

Figure 11Milk balloon contour initial

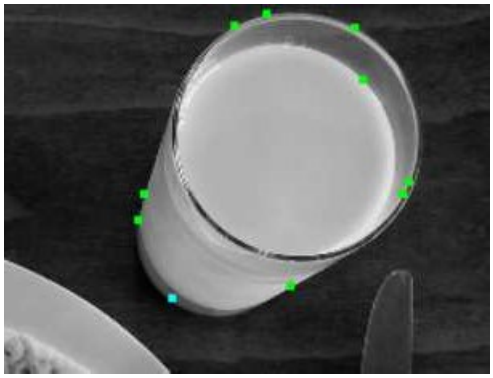

Figure 12 Milk balloon contour final after readjusting some points

First, I tried to perform the contouring without any weights as I had done in the Lab 5 but that did not work in this case so I had to determine the weights that can be implemented and would give good results. I also implemented more than 3 energies to improve the performance in the ballooning model. Additional fine tuning of the weights would yield better answers. I also tried more than 3 energies in the shrinking model, but the model did not give better results and the best results were achieved with three energies, so I moved forward with three energies for shrinking. $\mathrm{E} = 2 * \mathrm{Einternal1} + 4 * \mathrm{Einternal2}$ - $\mathrm{Eexternal1} + 1.2 * \mathrm{Eexternal2} + \mathrm{Eexternal3},$ this is the total energy equation I used for more than 3 energies in shrinking model which did not work properly.

Conclusion:

From this project I have learned how the energies affect the motion of the contour points. The internal energies help the points to move towards each other or expand accordingly and external energy helps the points to pull towards the edge pixels and same color pixels.

I also learned that we could use multiply energies which can pull the contour points is different ways would make the model more flexible to changes in edges and shapes. The window size also plays an important role in the contouring part as if the window is large enough the image data can help the better calculation of the external energy and can lead to better contouring, but the window should not be very large as it might attract it towards a different local minimum.