ECE 6310: Introduction to Computer Vision - Lab 3 Report
Active Contours

Objective: To implement the active contour algorithm. The program must load a grayscale PPM image and a list of contour points. The contour points must be processed through the active contour algorithm using the options given. The program must output a copy of the image with the initial contour drawn on top of it, and a second image with the final contour drawn on top of it. The program must also output a list of the final contour pixel coordinates.

Implementation and steps:
1. Original input image(hawk.ppm) and initial contour locations file(hawk_init.txt) were read and checked if read correctly. The input image is shown below with and without contours display.

Fig. 1 hawk.ppm

Fig 2. Hawk.ppm with initial contour

2. Based on rows, columns, x position and y position coordinates, the location for initial contour display was found and it was plotted on the image as given above. The window size for '+' shape was 7*7 and the pixel value was set to 0 for that window.

3. The external energy term was the square of the image gradient magnitude, and convolution with a sobel template was required. For edge detection, following 2 kernels were used:

$$\mathbf{G}_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} * \mathbf{A} \quad \text{and} \quad \mathbf{G}_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix} * \mathbf{A}$$

Fig 3. Sobel filter kernels

The image after convolution was normalized using the range and minimum value. The values were written to a ppm file after edge detection and the following result was obtained:

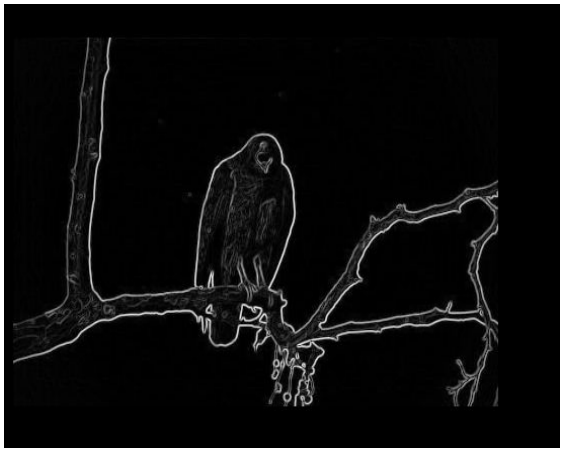

Fig. 4 Sobel Edge Gradient Magnitude Image

4. The output of sobel edge detection was passed to active contour algorithm function, along with the current contour position (head). 2 internal energy terms and 1 external energy term were used by the program. 7*7 window size was used for the operations, total number of iterations were 30. The energy terms were as follows:

Internal energy 1: Square of distances between points
Internal energy 2: Square of the deviation from the average distance between points
External energy 1: Square of the image gradient magnitude, which was calculated using convolution with a Sobel template.

It was assumed that the contour encloses an area, so that the last contour point was connected to the first contour point to calculate internal energy terms. After calculating the energies, the terms were normalized by rescaling from min-max value and min total energy was found. The contour position was then updated to the lowest total energy location in the 7*7 window.

Results and Observations:

The image with the initial contour is displayed, along with the image with the final contour for comparison below:

Fig 5. Initial contour positions

Fig. 6 Final contour positions

The image coordinates of final contour are:

266	108
274	119
278	134
278	147
277	161
274	170
269	183
264	195
259	207
255	219
256	230
256	241
246	242
235	245
225	242
229	232
222	246
217	264
206	266
195	260

195	246
186	242
185	228
187	217
180	214
181	203
182	192
183	181
184	170
186	159
188	149
191	140
194	131
197	122
203	112
213	105
222	100
231	93
241	85
252	85
260	89
265	99