Fall 2017

Midterm Exam Report

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1 Summary of the two methods

1.1 hedcuter method

1. input : Image 'I', number of samples 'N', configurations 'C'

2. Generate uniform random distribution of site 'S' on image greyscale 'Ig' where number of S := N

3. initialize Centroidal Voronoi diagram CVT with C

4. Compute Weighted CVT

if configuration gpu Cgpu ==true then

input: I, S

else

input: Ig, S

endif

create

4.1. for each site s in S, do:

create a new cell called "cell", with s as its site

//Lloyd's Algorithm

4.2 Perform Lloyd Algorithm

while distance moved is not greater than displacement Cd and iteration 'It' is less than Ci

4.3 compute voronoi

Increase virtual resolution of image I by subpixel sp

for each cell in cell CELL, do // here CELL is a list of all cells

get the pixel color intensity of cell point px and py from the image I

//the intensity is an integer value from 0 to 255 representing the pixel color of the image from 1 - black to 255 - white

endfor

//we only require distance greater than 0 therefore use 256 and 1.0f

construct a priority queue (heap) whereby the priority point p (first) is the one with the greatest distance , if same distance then get the one with the biggest px and py

while priority queue not empty, do

get the cell of least priority from the priority queue (shortest distance)

if the cell has already been moved or the cell has already been visited:

nothing to be done, so get the next element from queue

else

if px neighbors (px-1 and px+1) and py neighbors (py-1 and py+1) are within the boundary of the image height and width and their color intensity is darker than the current position

move the point at current site to the position of the neighbor

endif

endif

remove cell from priority queue

4.4 compute maximum distance moved

input: list of cells CELL, Image I, Configuration C

for each cell in CELL

if Cavg, then //Cavg - average termination , so if Cavg == true referring the provided code.

return average distance moved by all cells

else

return total distance moved by the cell

endif

//this distance is used to by the while loop if it is greater than the one specified then break loop

go: display result

the difference between having the gpu enabled is for performance, the gpu is effective for graphics processing because it has a huge parallel processing architecture.

1.2 voronoi method

1. Generate uniform random distribution of site 'S' on image greyscale 'Ig' where number of S := N

2. Initialize points P and edges E to be empty.

3. For each site $_{site}$ in S do:

4. create new cell $_{cell}$ with $_{site}$ as it site:

5. For each existing cell c in C where C is set of all c do:

6. find the perpendicular bisector (line that passes through the two sites s) called Pb and store it as critical points edgelist

compute voronoi

7. for each edge e of cell c, do,

8. identify the connection between the edge e and c if edge has c

9. if e is near the side of the critical point then mark it for deletion

10. if e intercept the critical point then perform clipping on e and put the point of interception in critical points edgelist

11. if the has two points, create new edge by connecting them, then mark it and add it to the edges E and $_{cell}$.

12. add $_{cell}$ to C

13. for each side border of rectangle, do

14. create a priority queue P to hold the critical points and add the end points of the border to the priority queue P

15. for each edge in E do,

16. test relationship between e and border

17. if e outside border then mark the edge for deletion

18. if e intersects border then clip e to the inside of the border and store in the queue

19. create new edge to connect adjacent points in P and add the edge to E

20. delete all irrelevant edges

2 Comparison of the two methods

1. Do you get the same results by running the same program on the same image multiple times?

No it doesn't produce the same svg if you run the same program on the same input multiple times, probably because the each time to program runs it generates a random distribution of points using the current time so unless they are run at the exact same time then it wouldn't be the same output. therefore the same program might result in different points distribution or samples. This has been shown in the folder report/compare/compare1 which has the same program running on the same image but outputting different results, it was check by using git-diff terminal to find the svg tags that are different.

2. If you vary the number of the disks in the output images, do these implementations produce

No they do not because the generation algorithm used in voronoi is boost and the one used in hedcut is opencv and the algorithm for the voronoi differs from that of the other. voronoi uses edges and point and hedcut just moves the image based on the intensity of pixel in the image.

3. If you vary the number of the disks in the output images, is a method faster than the other?

Yes voronoi is faster for bigger numbers of disks while hedcut is used for smaller ones. I found this by having 5 variations of n (n being the number of disks) of each method and then getting 5 time and finding the average of the times for each of the methods. Everything else stays same. The output is tabulated below. I believe the reason for this is because for many points there is a chance that the hedcut will keep moving a point back an forth therefore taking longer.

N of disks	Hedcuter Method (avg of 5 runs)s (rounded to 2dp)	voronoi Method (avg of 5 runs)s
200	12.94	15.28
500	11.65	10.27
1000	12.57	8.34
2000	13.91	5.94
5000	14.86	4.93

4. Does the size (number of pixels), image brightness or contrast of image increase or decrease

Yes, for images with more pixels the hedcut takes a longer time to finish the process. The voronoi is constant. The information is shown below:

The average time of 5 run on the normal image resolution and a smaller resolution. With the parameters of 4000 disks radius of and iteration of 1000 for hedcut. Image was the fairyeyes.png

500x756 res:72pixels, average(s)	450x600,res:80pixels, average(s)
30.04	12.70

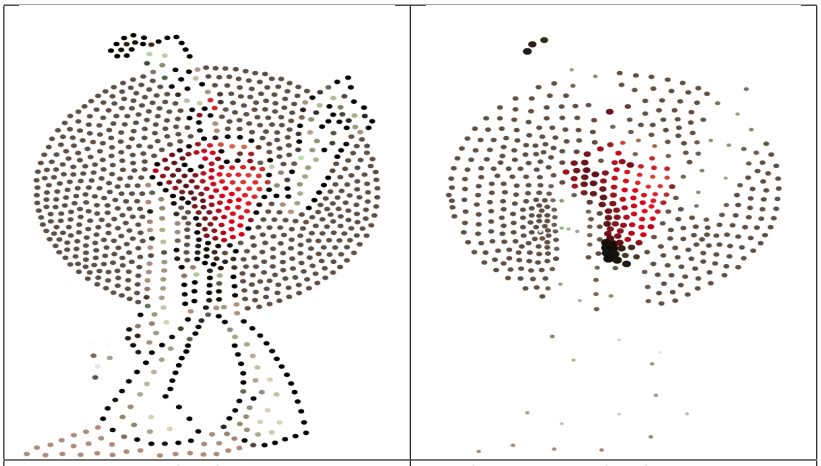
Sample image below:

	
width:567pixels, height:756pixels resolution:72pixels/inch (average) in seconds , resolution:80pixels (average) in seconds	width: 450pixels, height:600pixels

5. Does the type of image (human vs. machine, natural vs. urban landscapes, photo vs. painting,

Yes, it does. The voronoi method performs best and output visibly pleasing distributions, while in hedcuter method the because of the moving of points the output is not clear, that is it does

produce an output. The size of images, the intensity of the pixels in the image and especially color has a big effect on the hedcuter method. Below shows the sample of hedcuter and voronoi on the klaymen.png.

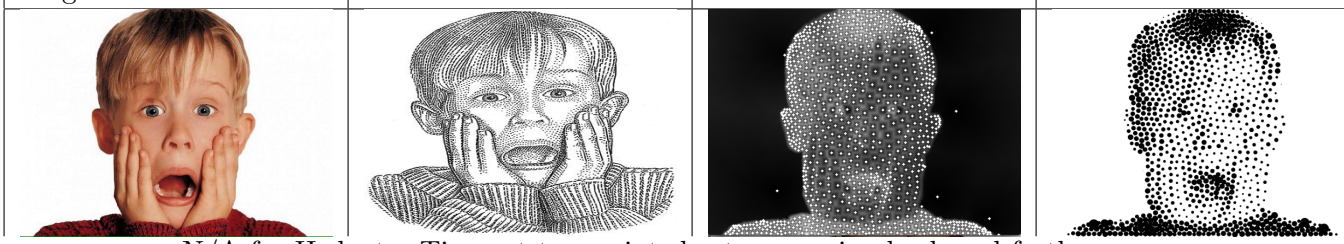


voronoi Method	Hedcuter Method

6. Are the outputs of these stippling methods different the hedcut images created by artists (e.g.

I picked up an image from wall street shown in the folder report/compare6 in the folder hedcuter/code/build. The images of the artist, voronoi method and hedcuter method are shown below.

Original	Artist	voronoi Method	Hedcuter Method



N/A for Hedcuter Timeout two points kept on moving back and forth

It appears that the image from the artist has better tones and the radius is much better. However in the voronoi method the image come pretty close in the tones especially when the input from the user is limited. The hedcuter method has a problem with colors because it works based on color intensity at a particular position in the image and therefore in an image with high intensity it will take a lot of time moving the point from one position to another which can go on for a very long time (performance issues).

3 Improvement of hedcuter method

Provide at least two improvements (each will worth 20 points) to the hedcuter code. Below are

I added a quicker sorting algorithm using the insertion sort, that way the number of swapping done by the std::make_heap(open.begin(), open.end(), compareCell); in wcvt.cpp will be less substantially therefore reducing the time taking to compute in the hedcuter. I showed below the time

difference for the normal make heap and the one with insertion sort of the vector before. You can do the same test by uncommenting the start and end time in the CVT::vor(cv::Mat & img) method in wcvt.cpp. You can enable this by simply adding -useqsorting (stands for use quicker sorting) to the argument when running hedcuter. I have added two text files showing the average using quicker sorting method and the original method (located in report/improvement) and have concluded that the time it takes with quicker sorting technique is faster than the original method.

I also added a graph that will be used to uncluster the disks to improve the distribution. You can do this by using the two options -gclusterv (this will be in integer to specify the number of disks that are clustered together, if the number of disks are greater than -gclusterv then it will remove the clusters and generate another point somewhere else) and -gclusterdist (this is the distance between disks so if the distance between two disks is -gclusterdist it will add the edge). The aim is that if the number of edges of a point is more than the cluster value then uncluster.

A timer has been added to stop the iterations when it goes beyond a certain limit specified by the user using -timeout_count (example -timeout_count 30500)

I also wanted to add another option that will create a list for already existing points that was if the point in hedcuter has moved to a position it cannot move back to that position again. This will improve the hedcuter for images with bigger resolution and also improve the hedcuter for colored pixels. If the point is moved to that position it will add it position to the list then everytime its going to move, it will check the list to see if that position has been moved to already.