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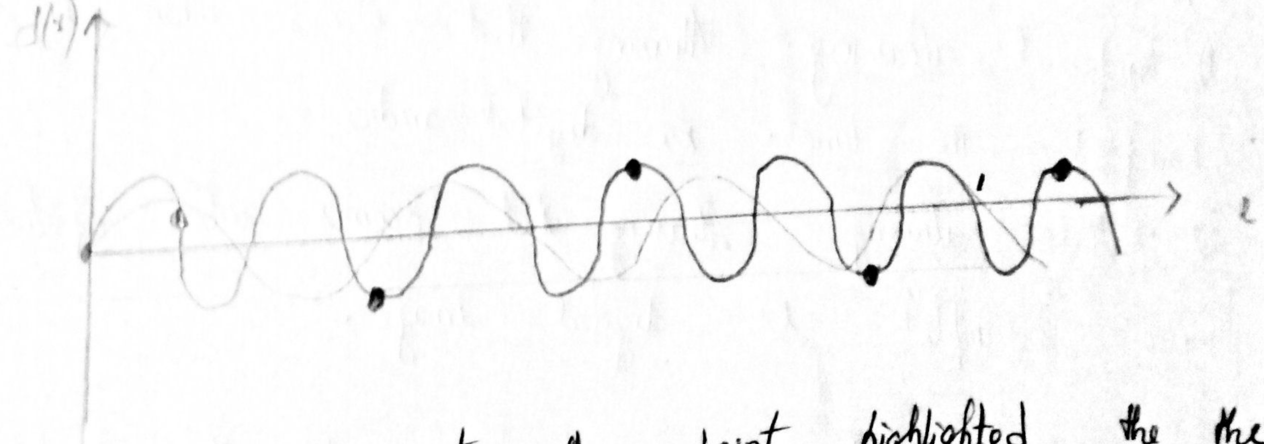
CGM Mid Exam Set-2

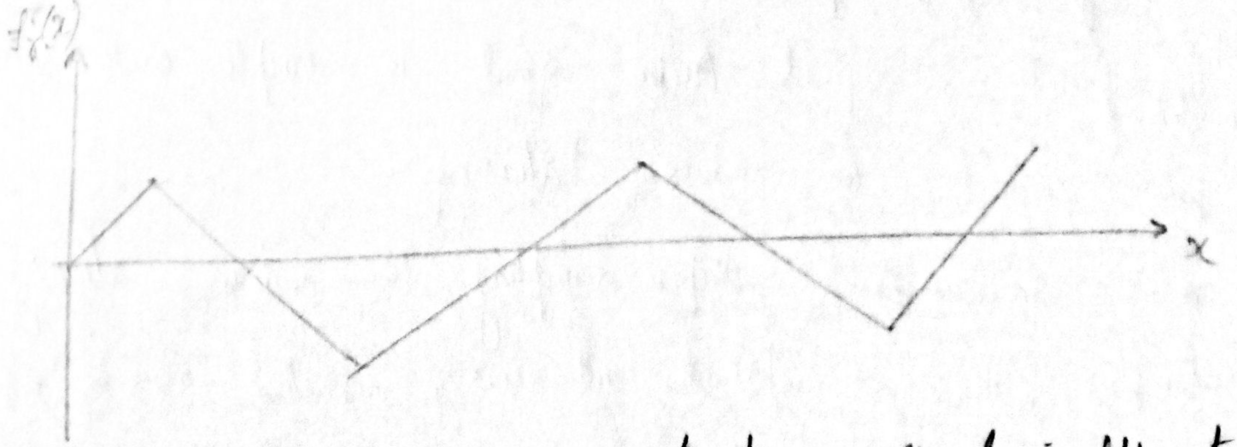
Question 1

Aliasing is an effect that causes different signals to become indistinguishable when sampling is done to reconstruct the signals. Aliasing is the error or distortion that results when a signal reconstructed from samples is different from original continuous signal.

for example consider we are trying to sample and reconstruct the following high frequency signal.



If we sample at the point highlighted the the reconstruction looks like this.



As we can see the reconstruction signal is different from original in every aspect, example frequency etc

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This distortion that we observed is called as aliasing.

Aliasing mainly occurs because of under-sampling or sampling at lower frequencies. In the given example if we had more sampling points we could have reconstructed properly but since we didnt sample them we ended up with aliased signal.

Different types of Aliasing:-

1) temporal aliasing. Aliasing that occurs when signals are sampled in time. Ex- digital audio.

2) spatial aliasing - Aliasing that occurs when spatial signal are sampled. Ex - digital Image.

To reduce aliasing we can sample the signal at higher sampling frequencies, this enables us to reconstruct the appropriate signal. Audio signal is sample over 44000 times per second to reduce aliasing.

We can also use super sampling to reduce aliasing. Super sampling is a spatial - anti aliasing method used to remove aliasing from images rendered. fourier and Inverse fourier transformations are used.

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Question 2

To check if a point lies inside a triangle, we check if the point is contained in three half planes associated with the edges. If q is the point and P_0, P_1, P_2 are vertices of triangle then we have to check if q is contained by the half planes of P_0P_1, P_1P_2 and P_0P_2.

To check whether q (a point) is contained in the half plane P_iP_j, we have to find whether q is to the left or right of the line from P_i to P_j. There are many approaches to implement this and one such approach is parallel coverage tests.

Parallel coverage test :-

This method allows for wider test coverage than sequential tests in the same timeframe. Modern hardware is highly parallel. So, we test all samples in triangle "bounding-box" in parallel.

Most triangles cover many samples when we implement super sampling, this eliminates aliasing. So, wide parallel execution overcomes the cost of extra tests. All of the tests share

Some setup calculations. Modern graphical processing units (GPU's) has special purpose hardware for efficiently performing point-in-triangle tests. This approach is not so effective when most of the sample points are not covered by triangle.

Question 3

There are two algorithms for line drawing which are
i) DDA (digital differential analyser)
ii) Bresenham's line Algorithm.

In DDA (digital differential analyser) technique we mainly use the slope of line to iterate over the points and draw the line.

* This Algorithm is based on either Δy or Δx.
* Every point is generated from previous point and we start off with initial point.
* We take a unit step with one co-ordinate and the calculate the corresponding point.
* m = slope = $\Delta y / \Delta x$.
* There are many cases based on sign of the slope and the direction, quadrant of the line.

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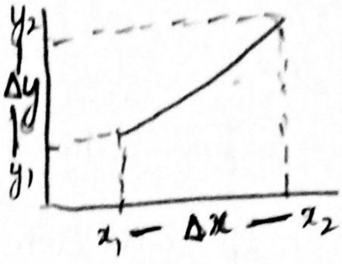
* slope is positive $(m > 1)$ or negative $(m <= 1)$
Direction : (left - right) or (right - left)

* Based of the case we write the algorithm



$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

→ Go to starting point.
→ Increment x and y values by step size.

step size
⇒ increase one unit ~~in~~ either in x or y
⇒ calculate the corresponding point using $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$

→ Round it up to closest value.

→ continue with same procedure until you reach target or you reach the count of number of points that you would like to have.

Advantages : It is relative fast compare to other algorithm with time complexity $O(n)$ with n = number of points.

Disadvantages : It ~~uses~~ uses floating ~~p~~ arithmetics which causes approximations and errors.

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Question 4

There are two techniques to find Inside-outside test.

1) Odd-Even rule.
2) Non-zero winding rule.

Non-zero winding rule:

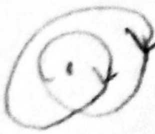
In this method we count winding number of point.

* If count $\neq 0$ then it is an "interior point".
* If count $= 0$ then it is an "exterior point".

* We calculate winding number of a close curve (loop) around a given point.
* The number of times the polygon edges wind counter clockwise around the point.
* We add +1 if the winding is counter clockwise, -1 if winding is clockwise around the point.

Ex:

winding number = +3



winding number = -2

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Steps

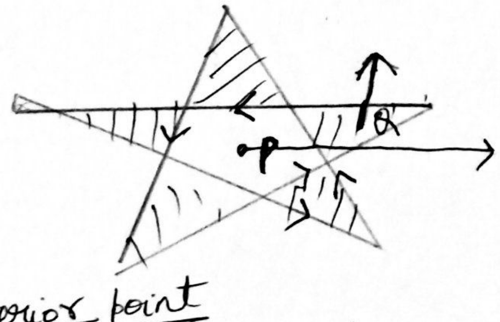
* Set each edge as a vector of polygon.
* Initially set values as zero.
* Now draw a line from point to very distant point beyond the co-ordinate extend.
* now count total number of vectors crossed.

Add 1 : If vector is in counter clockwise to the point

Subtract 1 : If vector is clockwise to the point

* finally if the the total value (winding number) is non zero, then ~~point~~ the point is interior point else it is exterior point.

Example



Interior point

* from Q we draw a line to nearest point beyond the co-ordinate extend.
* It touches only one vector right to left, i.e, in counter clockwise direction, hence we add +1.
* our winding number = 1 is non-zero, hence Q is interior point.

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Exterior point

* Draw a line from P to ~~a~~ nearest point beyond ~~from~~ co-ordinate extend.
* The line touches two vectors.
  * one vector which goes from left to right, i.e, clockwise hence we add −1,
  * one vector which goes from right to left, i.e, counter clockwise hence we add +1.
* resultant winding number = +1 − 1 = 0
* since winding number is 0, P is exterior point.