CS 576 Spring 2023– Assignment 1
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Assigned on 01/23/2023
Solutions due on 02/13/2012 by 2:00 pm afternoon
Late submissions guidelines: None

This assignment will help you gain a practical understanding of Resampling and Filtering in the spatial and temporal domain. It consists of two parts, the first one aimed to develop your understanding of sampling/aliasing issues in the spatial domain and the second one deals with sampling/aliasing issues in the temporal domain.

Part 1 –Spatial Resampling and Aliasing

In your program you will need to display two images side by side (in the same or two different windows) –

1. Your original image displayed on the left – This is an image of size 512x512 that you will create based on the criteria explained below.
2. Your processed output image displayed on the right – This image is the output of your algorithms on the original image above to create a resampled image depending on parameters explained below.

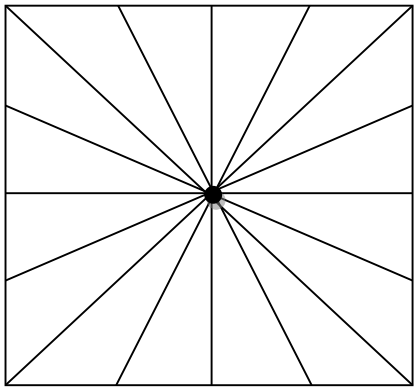
Input to your program will take three parameters:

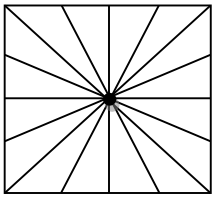
- The first parameter *n* is the number of lines to create an image with radial pattern of n black lines starting from the center of the image towards the boundaries. The image has a white background. Each consecutive line is separated by 360/*n* degrees. The idea here is by increasing n, you can increase the frequency content in an image.
- The second parameter *s* will be scaling value that scales the input image by a factor. This is a floating-point number eg – s=0.5 will scale the image down to 256x256. Note *s* will be a floating-point number between 0 and 1.0.
- The third parameter will be a Boolean value (0 or 1) suggesting whether or not you want to deal with aliasing. A 0 signifies do nothing (your output will have aliasing) – which means you need copy the direct mapped pixel value from input to output. A value 1 signifies that anti-aliasing should be performed – which means that instead of the direct mapped value you need to copy a low pass filtered value to the output. See lecture for more explanation of this in class.

To invoke your program, we will compile it and run it at the command line as

Mypart1.exe 16 0.5 0

This will create original 512x512 image to the left with 8 lines radially as shown, and the output is scaled down by 2.0 creating an image of size 256x256 as shown.





Similarly,
Mypart1.exe 360 0.5 0
Will create an image with a denser pattern with each line separated by one degree, ultimately scaled down to half its size.

Analysis Questions for part 1 – submit as a pdf or word document

1. Let's try an experiment where s (scale factor) remains constant and n (number of lines) is allowed to vary. Comment on your results by using various constant values of *s* for changing *n*. You may attach results, plot charts etc. to qualify your results.
2. Let's try another experiment, this time keep n (number of lines) constant and varying s (scale factor). Comment on your results by using various constant values of *n* for changing *s*. You may attach results, plot charts etc. to qualify your results.

Part 2 –Temporal Aliasing

In your program you will need to display two videos side by side –

1. Your original video displayed on the left – This is video of size 512x512 that you will create based on the criteria explained below. This is radial pattern just as in part 1, but it is also rotating clockwise at a certain specified speed. The creation and updating of your image at the respective times should simulate a rotating wheel.
2. Your processed output video displayed on the right – The output video is also of size 512x512 but in order to simulate temporal aliasing effects it will be given an fps rate of display, which means your output will be updated at specific times.

Input to your program will take three parameters where

- The first parameter *n* is the number of lines to create an image with radial pattern of n black lines starting from the center of the image towards the boundaries. The image has a white background. Each consecutive line is separated by 360/*n* degrees. The idea here is by increasing n, you can increase the frequency content in an image.
- The second parameter *s* will be a speed of rotations in terms of rotations per second. This is a floating-point number eg – *s*=2.0 indicates that the wheel is making two full rotations in a second, *s*=7.5 indicates that the wheel is making seven and a half rotations in a second. Remember this is the original input video signal with a very high display rate.
- The third parameter will be a *fps* value suggesting that not all frames of the input video are displayed, but only a specific frames per second are displayed.

To invoke your program, we will compile it and run it at the command line as

Mypart2.exe 64 4.0 10.0
In this case, the input video consists of images with 64 lines (as explained in part one), rotating clockwise at 4 revolutions per second (displayed on the left) and the right output is a temporally sampled version displayed at 10.0 frames per second. Here, for a rate of 4.0 rotations per second, the Nyquist factor is 8.0, so any fps above 8.0 should not result in temporal aliasing and the output should be the same as input.

Mypart2.exe 64 4.0 7.5
In this case, the input video consists of images with 64 lines (as explained in part one), rotating clockwise at 4 revolutions per second (displayed on the left) and the right output is a temporally sampled version displayed at 7.5 frames per second. Here, for a rate of 4.0 rotations per second, the Nyquist factor is 8.0, so any fps below 8.0 should result in temporal aliasing – manifested by the wheel not rotating the way it should

Analysis Questions for part 2 – submit as a pdf or word document
Let's try an experiment where *s* (speed of rotation) remains constant and *fps* (number of lines) is allowed to vary. Study the value of the *os* (observed speed of rotation) , especially when there is temporal aliasing.

1. Can you design a formula relating *s*, *fps* and *os*.

Evaluate if your formula works for certain values of *s* and *fps*. If *s* = 10 rotations per second,

2. What is the observed speed *os* for an *fps* of 25?
3. What is the observed speed *os* for an *fps* of 16?
4. What is the observed speed *os* for an *fps* of 10?
5. What is the observed speed *os* for an *fps* of 8?

Part 3 (Optional Extra Credit)
Change part2 of your assignment to take in two additional parameters –

- The fourth parameter will be a boolean value (0 or 1) suggesting whether or not you want to deal with aliasing. A 0 signifies do nothing (temporal aliasing will remain in your output). A value 1 signifies that temporal anti-aliasing should be

performed – you need to design a method to decrease temporal aliasing that shows better output videos.

- The fifth parameter *s2* will be a scale factor that scales the input video down by a factor. This is a floating point number eg – s=2.0 will scale the video down to 256x256. Note *s* need not be a complete integer. Also if the fourth parameter above is a 1, then you need to perform spatial antialiasing (like part1) along with temporal antialiasing.

Together with these two parameters you should be able to create scaled videos of your input at different frame rates and simultaneously minimize any aliasing effects due to resampling temporarily and spatially.

To invoke your extra credit we will compile it and run it at the command line as

MyExtraCredit.exe 64 4.0 7.0 1 1.0
In this case, the input video consists of images with 64 lines (as explained in part one), rotating clockwise at 4 revolutions per second (displayed on the left) and the right output is a temporally sampled version displayed at 7 frames per second. Here, for a rate of 4.0 rotations per second, the Nyquist factor is 8.0, will result in temporal aliasing which will have to be antialised. The output size does not change.

MyExtraCredit.exe 64 4.0 7.0 1 2.0
In this case, the input video consists of images with 64 lines (as explained in part one), rotating clockwise at 4 revolutions per second (displayed on the left) and the right output is a temporally sampled version displayed at 7 frames per second. Here, for a rate of 4.0 rotations per second, the Nyquist factor is 8.0, will result in temporal aliasing which will have to be antialised. The output size is also halved and it will induce spatial aliasing which will have to be antialiased as in part1.

What should you submit ?

- Your source code ONLY (no data or binaries), your project file or makefile, if any and your analysis questions answered in a pdf or a word document. You should submit your work make use of DEN's submit process. *Please do not submit any binaries or media files. You will be adversely penalized if you do*. We will compile your program and execute our tests accordingly.