

Shader Development LLOYD CASE 1818917

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LLOYD CASE 1818917
GPU PROGRAMMING
SHADER DEVELOPMENT

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Table of Contents

Blurring.....	1
What is blurring?	1
Different types of blurring	1
Gaussian blurring.....	1
Motion blurring	2
Depth of Field	2
Where & when to use these blurring effects.....	2
Sharpening.....	2
What is sharpening?.....	2
Post-Processing.....	3
Where to use sharpening	3
The Application	3
Code	Error! Bookmark not defined.
Main File	Error! Bookmark not defined.
Vertex Shader.....	Error! Bookmark not defined.
Fragment Shader	Error! Bookmark not defined.
References.....	4

Blurring

What is blurring?

Blurring is a technique that is used to make an image look blurry, it does this by reducing how sharp the image is. It makes the image look smooth and blurry, not as easy to see[1].

By blurring you lower the sharpness of an image, and this is done by averaging the colours of the pixels smoothing them into a similar colour so that it looks like they blend into each other, this is known as box blurring[2].

$$K = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = \frac{1}{3} [1 \quad 1 \quad 1] * \frac{1}{3} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

Mean filter with size 3×3

Image [2]

Different types of blurring

Gaussian blurring

Gaussian blurring comes from the mathematician Carl Friedrich Gauss[3]. Gaussian blurring is a technique that makes the image smooth and adds a blur effect. It is used to reduce noise and detail in an image[4]. It also preserves the edges better than other blurring methods[5]. Gaussian blurring essentially softens the image out and smooths the image by cutting out any pixel outliers[5]. It uses a bell-shaped curve to smooth the image thus creates

a smooth and soft looking image[6]. Gaussian blur looks very smooth and natural compared to other blurring techniques used.

Box/Average blurring

Box blurring is a technique that is used when blurring an image where the pixels smooth into an average colour of the surrounding pixels and blending them, so they look smooth, but this does result in an overall less detailed image as the colour of the pixels are changed[7]. This can be used to approximate Gaussian blur[7]. If this effect is repeated, then it can approximate the effect of Gaussian blur. This can be used in UI as it can create a central image to bring into focus by creating a background blur and enhancing focus on the UI[8].

Motion blurring

Motion blur is used to create the effect of something moving quickly, it does this by moving the camera or object and this results in the image being blurry with either the object or the background blurred to simulate moving quickly[9].

Motion blur is used when you want to have blur in the current scene this is used in racing games to simulate that you are going quick as you blur past the background with how fast you would be moving. Motion blur is also used in first person shooter games when you move the camera quick so that it feels smooth when moving.[10]

Depth of Field

Depth of field is another technique that is used in gaming and this effect makes it so that what you see looks layered, the background will be blurred and the main object/character on the screen will be in perfect clarity, this shows what you are meant to be focusing on as it draws your attention to what isn't blurred[11].

Where & when to use blurring effects

There are many ways to use the many different types of blurring. Helping with noise reduction to smooth out an image as well as depth of field effects to focus on the foreground or the background, and motion blur to create the effect of something moving quickly. These are helpful in games because you can use these effects effectively[12].

Sharpening

What is sharpening?

Sharpening is a post-processing technique that is used to make images clearer, this is often the case when used with other techniques such as upscaling. It enhances edges and makes the image look clearer[13]. Sharpening can also be used to improve the quality of an image and by doing this it will make the image more detailed[14]. Sharpening works in the opposite way to blurring by making sure that the colours on the pixels do not smooth into an average with each other, it aims to make them stand out and appear sharp[14].

What can it do?

Sharpening can do many things such as enhancing details, improving edges on images for more clarity, it can show the finer details of an image such as the individual strands of hair or cloth on clothes, it can increase the visibility of low contrast images by being able to outline those smaller unseen details[14].

Edge Definitions

Edge definitions are important to gaming and sharpening helps with edges because it helps with textures looking more distinct and with this it enhances the edges because it outlines the model and texture to show, however too much sharpening may create artifacts and making it look worse than before[15].

Over Applied

When sharpness is over applied to an image this can create problems and make the image look unnatural and fake. This is caused by applying the sharpness too many times and too strong, doing so creates an unpleasing image, it will make everything too sharp, and it won't be nice to look at. When sharpening edges in games it is important to not apply the filter too much, even if that means the edge doesn't look the greatest[16].

Post-Processing

Post-processing is an effect that is applied after the render of the game to increase the sharpness of the game and making it less blurry, this is applied usually alongside upscaling techniques because they lower the quality of the game and then post-processing helps bring the quality back[17].

Where/When to use sharpening

It is used in many ways to create a clearer image out of something that was blurry. Sharpening is used in a variety of ways in gaming and is generally used for enhancing textures, this is most visible when looking at edges as they appear much sharper[18]. Sharpening is now included in games as forms of AI upscaling such as Nvidia DLSS and AMD FSR, this renders your game in a lower resolution and improves performance with the visual quality looking the same due to the sharpening[19]. Sharpening is used in VR as the headsets usually have a low resolution and the sharpening helps increase the quality.

The Application

In the application that was created, it needed to produce an image with the top half being blurring and the bottom half being sharpening. This was successfully created and when launched it shows these effects on the image.

Stb_image was used to import the image used as it is needed for applying textures. It is a public domain image loader for c++.

When creating the application OpenGL was used to produce it. The shader files were loaded from separate shaders that were created that contain what is needed to create these effects on the image. In the fragment shader is where the code for these effects are and they check for these effects. They are hard coded into the code so it would take work to change these effects if needed. It makes sure that the blurring stays on the top half and that the sharpening is only applied the bottom half of the image as shown. Blur kernel and Sharpen kernel were used to produce these effects.

```
// Blur kernel
```

```
const float blurKernel[9] = float[]
```



```
(1.0/16.0, 2.0/16.0, 1.0/16.0,  
2.0/16.0, 4.0/16.0, 2.0/16.0,  
1.0/16.0, 2.0/16.0, 1.0/16.0);  
  
// Sharpen kernel  
const float sharpenKernel[9] = float[9]  
(-1.0, -1.0, -1.0,  
-1.0, 9.0, -1.0,  
-1.0, -1.0, -1.0);
```

These are the algorithms used to produce these effects, and the numbers increase and decrease the effect of the effects on the image.

The image is loaded through a file path that is in the code; to change the image you would have to change it in the code so that it loads that specific image instead. There are error checks for things that could go wrong so that you will be able to know where the issues are. There are also checks in the command box that shows if the shader files were loaded correctly as well as if the texture was loaded correctly. The application window expands and shrinks to the size that you change it too.

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GRADEMARK REPORT

FINAL GRADE

72/100

GENERAL COMMENTS

===== MARKING GRID =====

1. Engagement with Literature Skills [20]
- Review of GPUs/shaders

15

Knowledge and Understanding Skills [10]
- Understanding shader/GPU architectures
- Evident in review + code 6

Cognitive and Intellectual Skills [25]
- Critical review of literature
- Problem analysis & solution design 17

Practical Application Skills [40]
- Solution/testing in C++ OGL + shaders 30

Transferable/Professional Skills [5]
- Report writing & referencing 4

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TOTAL 72/ [100]

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

