ECE4893A/CS4803MPG: Multicore and GPU Programming for Video Games

Postprocessing

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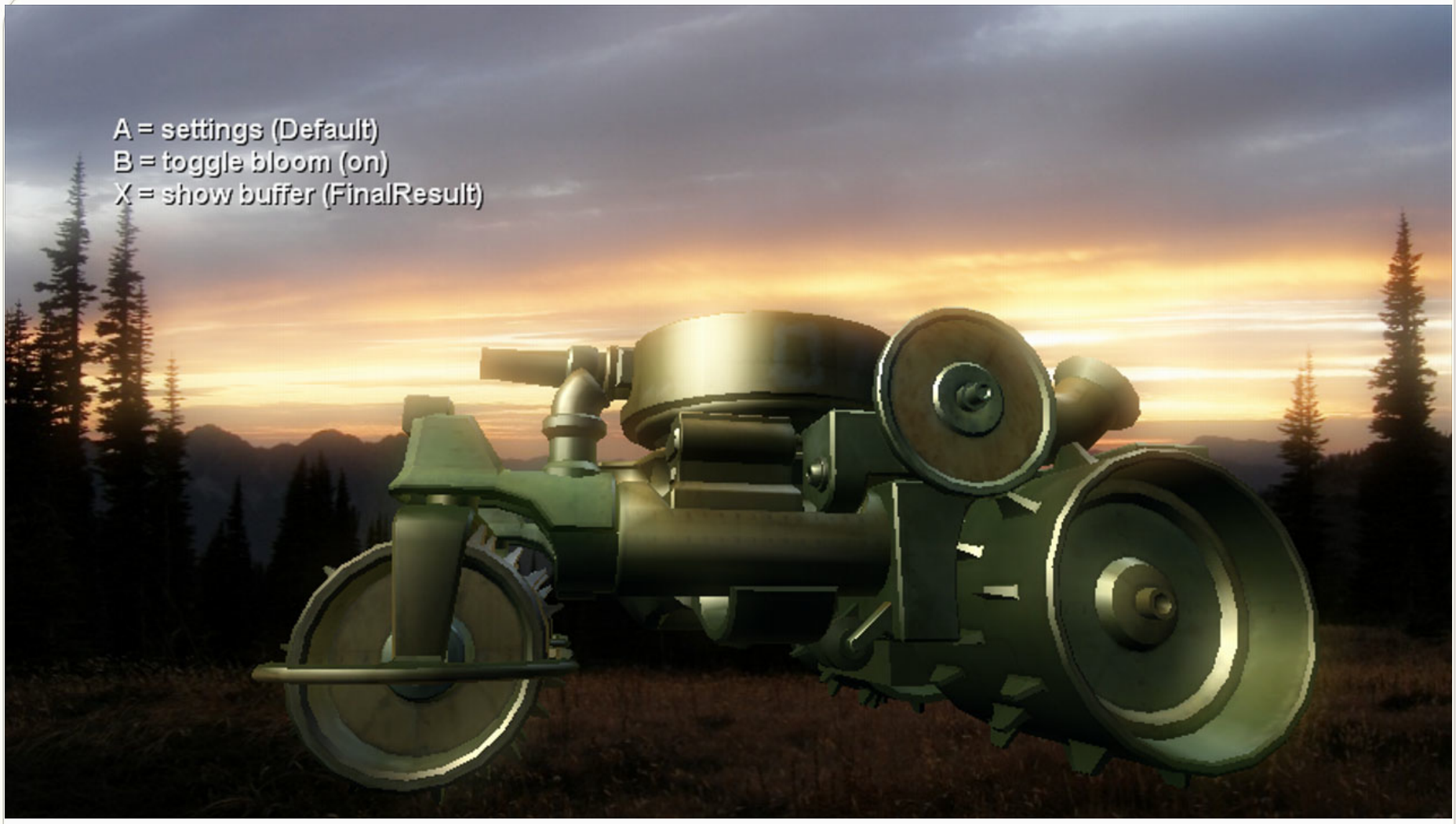
Bloom effect - before



http://creators.xna.com/en-us/sample/bloom

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Bloom effect - after

http://creators.xna.com/en-us/sample/bloom

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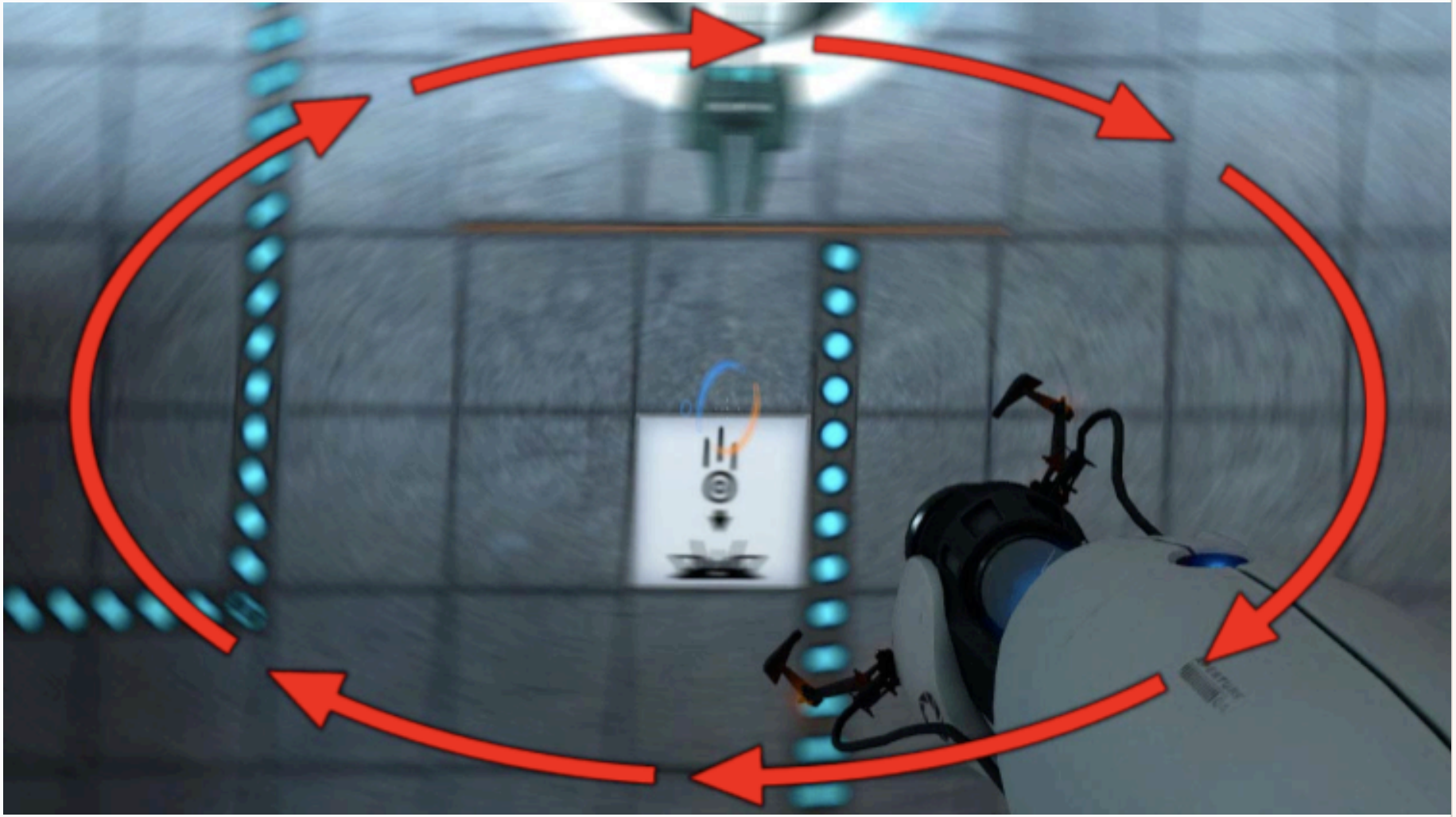
Motion blur in Valve's Portal - roll



http://www.valvesoftware.com/publications/2008/GDC2008_PostProcessingInTheOrangeBox.pdf

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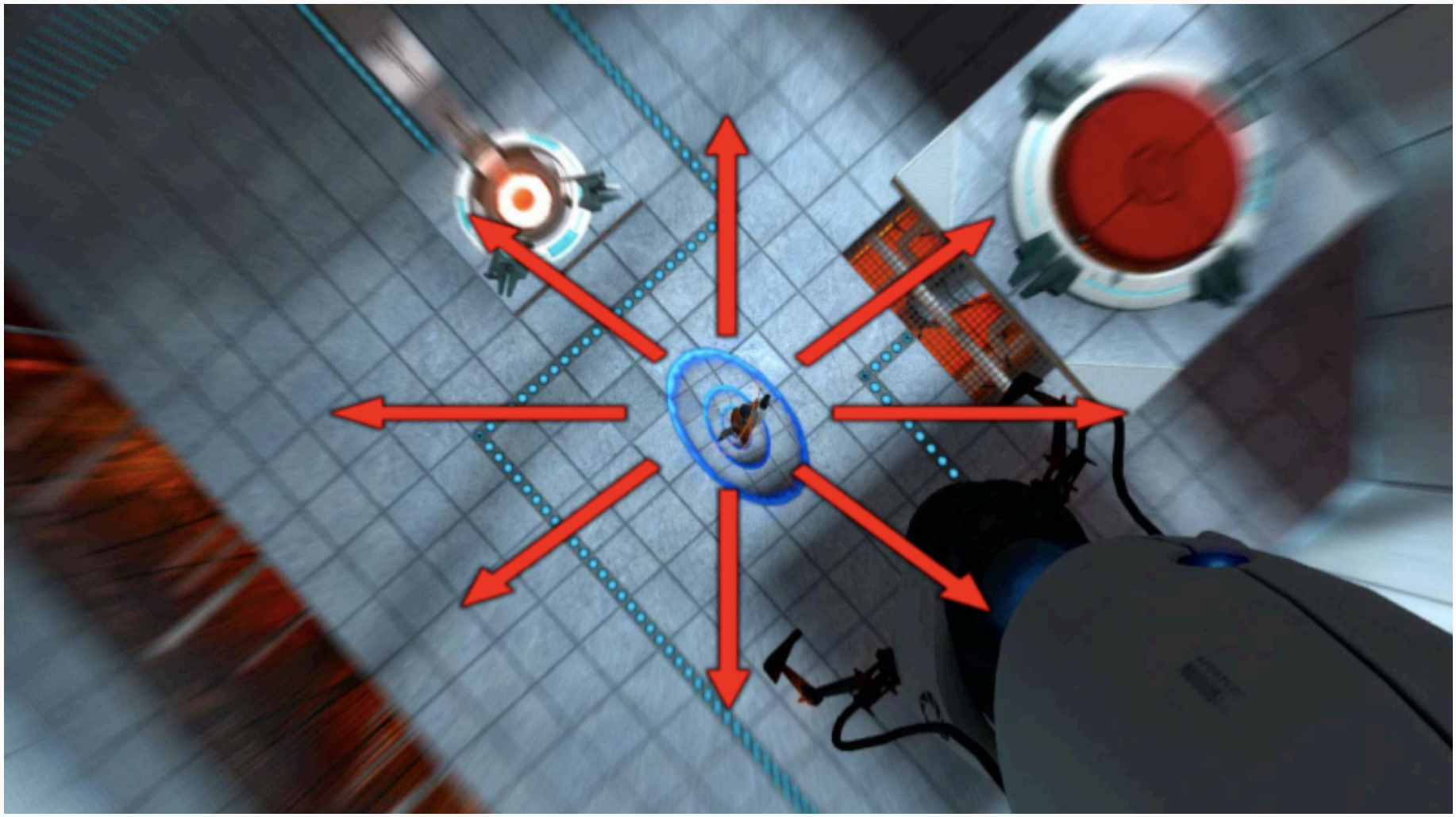
Motion blur in Valve's Portal - falling



http://www.valvesoftware.com/publications/2008/GDC2008_PostProcessingInTheOrangeBox.pdf

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Giant warning

The code in these slides has not been tested.

There may be bugs and/or misconceptions.

Typical XNA setup code

```
GraphicsDeviceManager graphics =
  new GraphicsDeviceManager(this);

ContentManager content =
  new ContentManager(Services);

GraphicsDevice device =
  graphics.GraphicsDevice;
```

Setup for postprocessing

```
SpriteBatch mySpriteBatch;
RenderTarget2D myRenderTarget;
Texture2D beforeProc;
Effect ppEffect;

ppEffect =
  content.Load<Effect>(@"Content\Effects\CoolEffect");
```

Based on discussion on p. 277-281 of Chad Carter, "Microsoft XNA Unleashed," 2008

Creating the rendertarget

```
myRenderTarget =
  new RenderTarget2D(device,
                     device.Viewport.Width,
                     device.Viewport.Height,
                     1, // number of mipmap levels
                     device.DisplayMode.Format
                     // a SurfaceFormat)

Vector2 offset = new Vector2(0,1 / device.Viewport.Height);
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

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Creating the rendertarget (advanced)

```
myRenderTarget = new RenderTarget2D(device,
device.Viewport.Width,
device.Viewport.Height,
1,                                  // number of mipmap levels
device.DisplayMode.Format,                  // a SurfaceFormat
sevice.PresentationParameters.MultiSampleType,
sevice.PresentationParameters.MultiSampleQuality)
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

SurfaceFormat enumeration

Member name	Description
Alpha8	(Unsigned format) 8-bit alpha only.
Bgr233	(Unsigned format) 8-bit BGR texture format using 2 bits for blue, 3 bits for green, and 3 bits for red.
Bgr24	(Unsigned format) 24-bit BGR pixel format with 8 bits per channel.
Bgr32	(Unsigned format) 32-bit BGR pixel format, where 8 bits are reserved for each color.
Bgr444	(Unsigned format) 16-bit BGR pixel format using 4 bits for each color.
Bgr555	(Unsigned format) 16-bit BGR pixel format where 5 bits are reserved for each color.
Bgr565	(Unsigned format) 16-bit BGR pixel format with 5 bits for blue, 6 bits for green, and 5 bits for red.
Bgra1010102	(Unsigned format) 32-bit pixel format using 10 bits each for blue, green, and red, and 2 bits for alpha.
Bgra2338	(Unsigned format) 16-bit BGRA format using 2 bits for blue, 3 bits each for red and green, and 8 bits for alpha.

Screenshot from
msdn2.microsoft.com/en-us/library/microsoft.xna.framework.graphics.surfaceformat.aspx

Direct3D/XNA SurfaceFormat Conversions

	Direct3D Surface Format	SurfaceFormat equivalent
Floating Point		
Float32	D3DFMT_R32F	Single
	D3DFMT_G32R32F	Vector2
	D3DFMT_A32B32G32R32F	Vector4
Float16	D3DFMT_R16F	HalfSingle
	D3DFMT_G16R16F	HalfVector2
	D3DFMT_A16B16G16R16F	HalfVector4
Unsigned Normalized		
64 bpp	D3DFMT_A16B16G16R16	Rgba64
32 bpp	D3DFMT_A8R8G8B8	Color
	D3DFMT_X8R8G8B8	Bgr32
	D3DFMT_A8B8G8R8	Rgba32
	D3DFMT_X8B8G8R8	Rgb32
	D3DFMT_A2R10G10B10	Bgra1010102

Screenshot from
msdn2.microsoft.com/en-us/library/microsoft.xna.framework.graphics.surfaceformat.aspx

Rendering the preprocessed scene

```
device.SetRenderTarget(0,myRenderTarget);
// On Xbox 360, first argument must be set to zero
// since you only can set one Render Target on the 360

// PUT CODE TO DRAW STUFF HERE

// in XNA 1.0, needed to ResolveRenderTarget on Xbox 360
// to copy eDRAM contents to main RAM, but not on Windows
// in XNA 2.0, don't need this line anymore on either platform
device.ResolveRenderTarget(0);

beforeProc = myRenderTarget.GetTexture();

// Set render target to the usual backbuffer
// in XNA 2.0, resolving happens automatically here
device.SetRenderTarget(0, null);
```

Based on discussion on p. 277-281 of Chad Carter, "Microsoft XNA Unleashed," 2008 and

http://blogs.msdn.com/shawnhar/archive/2007/11/21/rendertarget-changes-in-xna-game-studio-2-0.aspx

Setting up the postprocessing effect

```
myEffect.CurrentTechnique = effect.Techniques[“BlurEffect”];

myEffect.Parameters[“offset”].SetValue(offset);
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

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Drawing the processed scene

```
device.Clear(Color.Black);
myEffect.Begin();
mySpriteBatch.Begin(SpriteBlendMode.None,
SpriteSortMode.Immediate, SpriteStateMode.None);
EffectPass pass = effect.CurrentTechnique.Passes[0]
pass.Begin();
mySpriteBatch.Draw(beforeProc, Vector2.Zero,
                   Color.White);
pass.End();
mySpriteBatch.End();
myEffect.End();
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

Just need a pixel shader

```
// CoolEffect.fx
sampler textureSampler;
float2 offset;

float4 threewayBlurPS(texCoord : TEXCOORD0) : COLOR0
{
  float4 color =
     (tex2D(textureSampler,texCoord)
    + tex2D(textureSampler,texCoord + offset)
    + tex2D(textureSampler,texCoord - offset)) / 3;
  return color;
}

technique BlurEffect {
      pass P0 {
            PixelShader = compile ps_2_0 threewayBlurPS();
      }
}
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

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Just need a pixel shader

```
sampler textureSampler
```

is sort of implicitly

```
sampler textureSampler : register(S0);
```

```
mySpriteBatch.Draw(beforeProc, Vector.Zero,
                   Color.White);
```

was sort of doing this somewhere:

```
device.Textures[0] = beforeProc;
```

Based on discussion on p. 277-281 of Chad Carter, “Microsoft XNA Unleashed,” 2008

Multiple textures

- In your C# code:

```
graphics.GraphicsDevice.Textures[0] = firstTexture;
graphics.GraphicsDevice.Textures[1] = secondTexture;
```

- In your shader code:

```
sampler firstSampler : register(s0);
sampler secondSampler : register(s1);
```

From msdn2.microsoft.com/en-us/library/
microsoft.xna.framework.graphics.graphicsdevice.textures.aspx

Rendertarget semantics on Windows

- If not multisampling, a single area of video memory can be used for rendering or as a texture
  - In XNA 1.0:
    - Contents of rendertarget not lost in XNA 1.0 on Windows
    - Resolve is a no-op
  - Rendertarget cleared in XNA 2.0 to emulate Xbox 360 behavior
- If multisampling, need large area to render into and small area to copy into
  - Resolve copies, downsampling as it goes
  - Contents of both buffers not lost (in XNA 1.0)

From Shawn Hargreaves, “Rendertarget changes in XNA Game Studio 2.0,” http://blogs.msdn.com/shawnhar/archive/2007/11/21/rendertarget-changes-in-xna-game-studio-2-0.aspx

Rendertarget semantics on Xbox 360

- Xenos GPU renders into only one physical rendertarget: 10 MB eDRAM
  - Cannot texture from eDRAM
  - Cannot render into main 512M RAM
- Must “resolve” to copy rendering in eDRAM back to main memory
  - Hardware designed to make this fast
  - Note from Shawn: “It is less obvious why the resolve call needs to clear the special memory, but apparently there is a performance gain from doing this: I don't pretend to understand why but I'm not going to complain as long as this keeps my Xbox running as fast as it does!”

From Shawn Hargreaves, “XNA rendertarget semantics,” blogs.msdn.com/shawnhar/archive/2007/02/04/xna-rendertarget-semantics.aspx