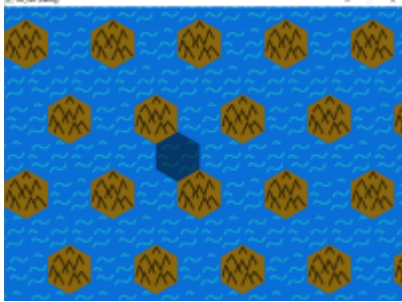


# Hexagon Grid Tutorial (Axial/Cubial Coordinates)

## Introduction

This tutorial showcases how to draw a hexagon grid using a shader, as well as using the mouse position to highlight specific hexagon tiles.



It is based off of the this [Hexagon Grid Tutorial](#), the key difference being that this example makes use of an axial/cubial coordinate system for pixel-to-hex calculations, as opposed to the grid-based system used by the old tutorial.

## Details

The axial/cubial coordinate system and associated mathematics used in this example are derived from the theory presented in this blog post: <https://www.redblobgames.com/grids/hexagons/>

## Source Code

A complete version of this tutorial's source code can be found at the following git repository:

[https://github.com/LudiG/tut\\_hex](https://github.com/LudiG/tut_hex)

This repository also contains hexagon resource files that can be used as textures for your hexagon shader.

**NOTE:** Pointy-top and flat-top hexagons use different texture files, so you will need to ensure that you match the right files with your hexagon layout.

## INI File (tut\_hex.ini)

### ORX Config File

```
[Display]
```

```
ScreenWidth = 800
ScreenHeight = 600
Title = Hexagon Grid Tutorial

[Input]
SetList = MainInput

[MainInput]
KEY_ESCAPE = Quit

[Viewport]
Camera = Camera
BackgroundColor = (210, 180, 140)

[Camera]
FrustumWidth = @Display.ScreenWidth
FrustumHeight = @Display.ScreenHeight
FrustumFar = 1.0
FrustumNear = 0.0
Position = (0.0, 0.0, -1.0)

[Object]
Graphic = OnePixel
Position = (-400.0, -300.0, 0.0)
Scale = (800, 600, 1.0)
ShaderList = Shader

[OnePixel]
Texture = pixel

[Resource]
Texture = ../data/texture

[Shader]
ParamList = radius # highlight # textures # texturesCount
UseCustomParam = true
radius = 50.0
highlight = (0.0, 0.0, 0.0)
textures = Hex_Water_PointyTop.png # Hex_Earth_PointyTop.png
texturesCount = 2
Code = "
```

## GLSL Shader Code

```
#define HEX_SIZE radius

#define HEX_WIDTH_POINTYTOP (sqrt(3.0) * HEX_SIZE)
#define HEX_WIDTH_FLATTOP (2 * HEX_SIZE)

#define HEX_HEIGHT_POINTYTOP (2 * HEX_SIZE)
```

```
#define HEX_HEIGHT_FLATTOP (sqrt(3.0) * HEX_SIZE)

// Function to convert cubial coords to axial coords.

vec2 cubeToAxial(vec3 cube)
{
    return vec2(cube.x, cube.y);
}

// Function to convert axial coords to cubial coords.

vec3 axialToCube(vec2 axial)
{
    float x = axial.x;
    float y = axial.y;

    float z = -x - y;

    return vec3(x, y, z);
}

// Function to round float cubial coords to int cubial coords.

vec3 cubeRound(vec3 cube)
{
    int rx = int(round(cube.x));
    int ry = int(round(cube.y));
    int rz = int(round(cube.z));

    float xDiff = abs(rx - cube.x);
    float yDiff = abs(ry - cube.y);
    float zDiff = abs(rz - cube.z);

    if ((xDiff > yDiff) && (xDiff > zDiff))
        rx = -ry - rz;

    else if (yDiff > zDiff)
        ry = -rx - rz;

    else
        rz = -rx - ry;

    return vec3(rx, ry, rz);
}

// Function to round float axial coords to int axial coords.

vec2 axialRound(vec2 axial)
{
    return cubeToAxial(cubeRound(axialToCube(axial)));
}
```

```
// Function to return axial hex-grid coords, given a screen position
(horizontal, pointy-top hex layout).

vec2 pixelToHex_PointyTop(vec2 point)
{
    return vec2(((sqrt(3.0)/3.0 * point.x) + (-1.0/3.0 * point.y)) /
HEX_SIZE, (2.0/3.0 * point.y) / HEX_SIZE);
}

// Function to return axial hex-grid coords, given a screen position
(vertical, flat-top hex layout).

vec2 pixelToHex_FlatTop(vec2 point)
{
    return vec2((2.0/3.0 * point.x) / HEX_SIZE, ((-1.0/3.0 * point.x) +
(sqrt(3.0)/3.0 * point.y)) / HEX_SIZE);
}

// Function to return a screen position, given axial hex-grid coords
(horizontal, pointy-top hex layout).

vec2 hexToPixel_PointyTop(vec2 hex)
{
    return vec2(((sqrt(3.0) * hex.x) + (sqrt(3.0)/2.0 * hex.y)) * HEX_SIZE,
(3.0/2.0 * hex.y) * HEX_SIZE);
}

// Function to return a screen position, given axial hex-grid coords
(vertical, flat-top hex layout).

vec2 hexToPixel_FlatTop(vec2 hex)
{
    return vec2((3.0/2.0 * hex.x) * HEX_SIZE, ((sqrt(3.0)/2.0 * hex.x) +
(sqrt(3.0) * hex.y)) * HEX_SIZE);
}

// Main shader.

void main()
{
    vec2 point = vec2(gl_FragCoord.x, gl_FragCoord.y);

    vec2 hex = axialRound(pixelToHex_PointyTop(point));

    float width = HEX_WIDTH_POINTYTOP;
    float height = HEX_HEIGHT_POINTYTOP;

    vec2 center = hexToPixel_PointyTop(hex);
    vec2 origin = vec2(center.x - (width/2.0), center.y - (height/2.0));
```

```

    vec2 textureCoord = vec2(((point.x - origin.x) / width), 1.0 - ((point.y
- origin.y) / height));

    int index = int(mod(hex.x * hex.y, texturesCount));
    vec4 color = texture2D(textures[index], textureCoord);

    if (highlight.xy == hex)
        color = mix(color, vec4(0.0, 0.0, 0.0, 1.0), 0.5);

    gl_FragColor = color;
}

```

```

"
```

## CPP File (tut\_hex.cpp)

```

/**
 * @file tut_hex.cpp
 * @date 2019/09/06
 * @author LudiG
 *
 * Axial/Cubial coord-based hexagon shader and mouse tracker.
 */

/* Orx - Portable Game Engine
 *
 * Copyright (c) 2008-2010 Orx-Project
 *
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 * warranty. In no event will the authors be held liable for any damages
 * arising from the use of this software.
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 *
 * 1. The origin of this software must not be misrepresented; you must
not
 * claim that you wrote the original software. If you use this software
 * in a product, an acknowledgment in the product documentation would be
 * appreciated but is not required.
 *
 * 2. Altered source versions must be plainly marked as such, and must
not be
 * misrepresented as being the original software.
 *
 * 3. This notice may not be removed or altered from any source
 * distribution.
 */

```

```
#include "orx.h"

orxFLOAT _screenHeight; // The screen height.
orxFLOAT _screenWidth; // The screen width.

orxFLOAT _tileRadius; // The tile radius in screen coordinates (pixels).

orxVECTOR _screenCoord; // The current screen coordinates of the mouse.
orxVECTOR _tilePos; // The current tile position.

// HEX

// Function to convert cubial coords to axial coords.

orxVECTOR cubeToAxial(const orxVECTOR& cube)
{
    orxVECTOR result;
    orxVector_Set(&result, cube.fX, cube.fY, 0.0);

    return result;
}

// Function to convert axial coords to cubial coords.

orxVECTOR axialToCube(const orxVECTOR& axial)
{
    orxFLOAT x = axial.fX;
    orxFLOAT y = axial.fY;

    orxFLOAT z = -x - y;

    orxVECTOR result;
    orxVector_Set(&result, x, y, z);

    return result;
}

// Function to round float cubial coords to int cubial coords.

orxVECTOR cubeRound(const orxVECTOR& cube)
{
    orxFLOAT rx = orxMath_Round(cube.fX);
    orxFLOAT ry = orxMath_Round(cube.fY);
    orxFLOAT rz = orxMath_Round(cube.fZ);

    orxFLOAT xDiff = orxMath_Abs(rx - cube.fX);
    orxFLOAT yDiff = orxMath_Abs(ry - cube.fY);
    orxFLOAT zDiff = orxMath_Abs(rz - cube.fZ);
}
```

```
    if ((xDiff > yDiff) && (xDiff > zDiff))
        rx = -ry - rz;

    else if (yDiff > zDiff)
        ry = -rx - rz;

    else
        rz = -rx - ry;

    orxVECTOR result;
    orxVector_Set(&result, rx, ry, rz);

    return result;
}

// Function to round float axial coords to int axial coords.

orxVECTOR axialRound(const orxVECTOR& axial)
{
    return cubeToAxial(cubeRound(axialToCube(axial)));
}

// Function to return axial hex-grid coords, given a screen position
(horizontal, pointy-top hex layout).

orxVECTOR pixelToHex_PointyTop(const orxVECTOR& point)
{
    orxFLOAT size = _tileRadius;

    orxVECTOR result;
    orxVector_Set(&result, ((orxMath_Pow(3.0, 0.5)/3.0 * point.fX) +
(-1.0/3.0 * point.fY)) / size, (2.0/3.0 * point.fY) / size, 0.0);

    return result;
}

// Function to return axial hex-grid coords, given a screen position
(vertical, flat-top hex layout).

orxVECTOR pixelToHex_FlatTop(const orxVECTOR& point)
{
    orxFLOAT size = _tileRadius;

    orxVECTOR result;
    orxVector_Set(&result, (2.0/3.0 * point.fX) / size, ((-1.0/3.0 *
point.fX) + (orxMath_Pow(3.0, 0.5)/3.0 * point.fY)) / size, 0.0);

    return result;
}

// Function to return a screen position, given axial hex-grid coords
```

*(horizontal, pointy-top hex layout).*

```
orxVECTOR hexToPixel_PointyTop(const orxVECTOR& hex)
{
    orxFLOAT size = _tileRadius;

    orxVECTOR result;
    orxVector_Set(&result, ((orxMath_Pow(3.0, 0.5) * hex.fX) +
    (orxMath_Pow(3.0, 0.5)/2.0 * hex.fY)) * size, (3.0/2.0 * hex.fY) * size,
    0.0);

    return result;
}
```

*// Function to return a screen position, given axial hex-grid coords (vertical, flat-top hex layout).*

```
orxVECTOR hexToPixel_FlatTop(const orxVECTOR& hex)
{
    orxFLOAT size = _tileRadius;

    orxVECTOR result;
    orxVector_Set(&result, (3.0/2.0 * hex.fX) * size, ((orxMath_Pow(3.0,
    0.5)/2.0 * hex.fX) + (orxMath_Pow(3.0, 0.5) * hex.fY)) * size, 0.0);

    return result;
}
```

*// ORX*

```
static orxSTATUS orxFASTCALL handleShaderEvent(const orxEVENT* currentEvent)
{
    switch(currentEvent->eID)
    {
        case orxSHADER_EVENT_SET_PARAM:
        {
            // Get the event payload.
            orxSHADER_EVENT_PAYLOAD *pstPayload =
            (orxSHADER_EVENT_PAYLOAD*)currentEvent->pstPayload;

            // look for the parameter of interest.
            if (!orxString_Compare(pstPayload->zParamName, "highlight"))
                orxVector_Copy(&pstPayload->vValue, &_tilePos);
        }
    }

    return orxSTATUS_SUCCESS;
}
```

```
orxSTATUS orxFASTCALL Init()
```

```
{
    orxDisplay_GetScreenSize(&_screenWidth, &_screenHeight);

    orxConfig_PushSection("Shader");
    _tileRadius = orxConfig_GetFloat("radius");
    orxConfig_PopSection();

    orxViewport_CreateFromConfig("Viewport");
    orxObject_CreateFromConfig("Object");

    orxEvt_AddHandler(ORXEVT_TYPE_SHADER, handleShaderEvent);

    return ORXSTATUS_SUCCESS;
}

ORXSTATUS ORXFASTCALL Run()
{
    ORXSTATUS result = ORXSTATUS_SUCCESS;

    // INPUT: Quit
    if(OrxInput_IsActive("Quit"))
        result = ORXSTATUS_FAILURE;

    // INPUT: Mouse
    ORXVECTOR mouse;
    OrxMouse_GetPosition(&mouse);

    _screenCoord.fX = mouse.fX;
    _screenCoord.fY = _screenHeight - mouse.fY;
    _screenCoord.fZ = 0.0;

    // Calculate the tile position from the mouse position.
    ORXVECTOR tilePosOld;
    OrxVector_Copy(&tilePosOld, &_tilePos);
    _tilePos = axialRound(pixelToHex_PointyTop(_screenCoord));

    // Print tile and screen position if mouse moves.
    if ((tilePosOld.fX != _tilePos.fX) || (tilePosOld.fY != _tilePos.fY))
        OrxLog("TILE: %f, %f FOR SHADER: %f, %f.", _tilePos.fX, _tilePos.fY,
        _screenCoord.fX, _screenCoord.fY);

    return result;
}

void OrxFASTCALL Exit()
{
    // No specific garbage-collection requirements.
}

ORXSTATUS ORXFASTCALL Bootstrap()
{
```

```
// Add the config directory as a resource path.
orxResource_AddStorage(orxCFG_KZ_RESOURCE_GROUP, "../data/config",
orxFALSE);

return orxSTATUS_SUCCESS;
}

int main(int argc, char** argv)
{
    orxConfig_SetBootstrap(Bootstrap);

    orx_Execute(argc, argv, Init, Run, Exit);

    return EXIT_SUCCESS;
}
```

From:  
<https://www.orx-project.org/wiki/> - **Orx Learning**

Permanent link:  
<https://www.orx-project.org/wiki/en/tutorials/shaders/hexagongrid2>

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