Kathmandu University

Department of Computer Science and Engineering

Dhulikhel, Kavre

Mini Report

on

“Lab 3”

[Course Code: COMP 342]

(For partial fulfillment of III Year/ I Semester in Computer Science)

Submitted By

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Submitted To

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Submission Date

14th January, 2024

1. Write a Program to implement mid- point Circle Drawing Algorithm.

Ans:

Algorithm

1. Start
2. Input the coordinates of two-line endpoints.
3. Store the left endpoint in (x0, y0).
4. Plot First Point:
5. Load (x0, y0) into the frame buffer (plot the first point).
6. Calculate Constants:
   - dx (change in x)
   - dy (change in y)
   - 2dy (twice the change in y)
   - 2dy - 2dx
7. Obtain the initial value for the decision parameter:
   - P0 = 2dy - dx
8. Point Calculation Loop:
   - For each xk along the line starting at k=0, perform the following tests:
   - If Pk < 0, then the next point to plot is (xk + 1, yk), and:
   - Update Pk+1 = Pk + 2dy
   - Otherwise, if Pk >= 0, the next point to plot is (xk + 1, yk + 1), and:
   - Update Pk+1 = Pk + 2dy - 2dx
9. Repeat Loop:
   - Repeat the above steps Δx times.

Stop

Source Code:

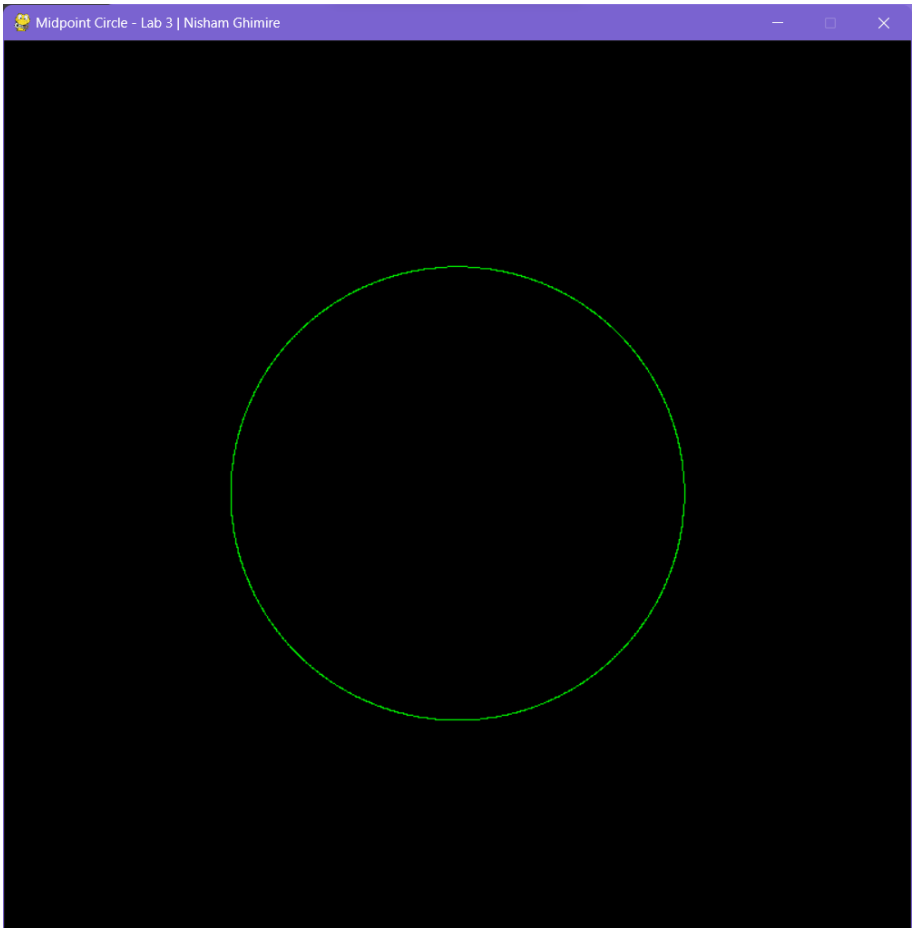
```
import ctypes
import numpy as np
from OpenGL.GL import *
from OpenGL.GLU import *
import pygame as pg
from pygame.locals import *

# Define Shaders
vertexShader = """
attribute vec2 position;
void main()
{
  gl_Position = vec4(position, 0.0, 1.0);
}
"""

fragmentShader = """
void main()
```

```
{
  gl_FragColor = vec4(0.0,1.0,0.0,1.0);
}
"""


def normalize(xList, yList, resolution):
    xList = [x / resolution for x in xList]
    yList = [y / resolution for y in yList]

    coordinateList = np.zeros((len(xList), 2))
    i = 0
    for _ in xList:
        coordinateList[i] = [xList[i], yList[i]]
        i += 1
    return coordinateList


def midpoint_circle(x_center, y_center, r, res):
    x = r
    y = 0
    # Printing the initial point the
    # axes after translation
    x_coordinates = np.array([])
    y_coordinates = np.array([])

    x_coordinates = np.append(x_coordinates, x + x_center)
    y_coordinates = np.append(y_coordinates, y + y_center)
    # When radius is zero only a single
    # point be printed
    if r > 0:
        x_coordinates = np.append(x_coordinates, x + x_center)
        x_coordinates = np.append(x_coordinates, y + x_center)
        x_coordinates = np.append(x_coordinates, -y + x_center)
        y_coordinates = np.append(y_coordinates, -y + y_center)
        y_coordinates = np.append(y_coordinates, x + y_center)
        y_coordinates = np.append(y_coordinates, x + y_center)

    P = 1 - r

    while x > y:

        y += 1

        if P <= 0:
            P = P + 2 * y + 1

        else:
            x -= 1
            P = P + 2 * y - 2 * x + 1

        if x < y:
            break

        x_coordinates = np.append(x_coordinates, x + x_center)
        x_coordinates = np.append(x_coordinates, -x + x_center)
        x_coordinates = np.append(x_coordinates, x + x_center)
        x_coordinates = np.append(x_coordinates, -x + x_center)
```

```
        y_coordinates = np.append(y_coordinates, y + y_center)
        y_coordinates = np.append(y_coordinates, y + y_center)
        y_coordinates = np.append(y_coordinates, -y + y_center)
        y_coordinates = np.append(y_coordinates, -y + y_center)

        if x != y:
            x_coordinates = np.append(
                x_coordinates,
                y + x_center,
            )
            x_coordinates = np.append(x_coordinates, -y + x_center)
            x_coordinates = np.append(x_coordinates, y + x_center)
            x_coordinates = np.append(x_coordinates, -y + x_center)
            y_coordinates = np.append(y_coordinates, x + y_center)
            y_coordinates = np.append(y_coordinates, x + y_center)
            y_coordinates = np.append(y_coordinates, -x + y_center)
            y_coordinates = np.append(y_coordinates, -x + y_center)

    return normalize(x_coordinates, y_coordinates, res)


tempData = midpoint_circle(0, 0, 500, 1000)
data = np.zeros(int(len(tempData)), [("position", np.float32, 2)])
data["position"] = tempData


def compileShader(source, type):
    shader = glCreateShader(type)
    glShaderSource(shader, source)

    glCompileShader(shader)
    if not glGetShaderiv(shader, GL_COMPILE_STATUS):
        error = glGetShaderInfoLog(shader).decode()
        print(error)
        raise RuntimeError(f"{source} shader compilation error")
    return shader


def createProgram(vertex, fragment):
    program = glCreateProgram()
    glAttachShader(program, vertex)
    glAttachShader(program, fragment)

    glLinkProgram(program)
    if not glGetProgramiv(program, GL_LINK_STATUS):
        print(glGetProgramInfoLog(program))
        raise RuntimeError("Error Linking program")

    glDetachShader(program, vertex)
    glDetachShader(program, fragment)

    return program


def main():
    running = True
    while running:
        width, height = 800, 800
```

```
        pg.init()
        pg.display.set_mode((width, height), DOUBLEBUF | OPENGL | GL_RGBA)
        pg.display.set_caption("Midpoint Circle - Lab 3 | Nisham Ghimire")
        glViewport(0, 0, width, height)
        # here inti()
        glClear(GL_COLOR_BUFFER_BIT)
        glClearColor(0.0, 0.0, 0.0, 1.0)
        glLoadIdentity()

        program = createProgram(
            compileShader(vertexShader, GL_VERTEX_SHADER),
            compileShader(fragmentShader, GL_FRAGMENT_SHADER),
        )

        glUseProgram(program)

        buffer = glGenBuffers(1)
        glBindBuffer(GL_ARRAY_BUFFER, buffer)

        stride = data.strides[0]
        offset = ctypes.c_void_p(0)
        loc = glGetAttribLocation(program, "position")
        glEnableVertexAttribArray(loc)
        glBindBuffer(GL_ARRAY_BUFFER, buffer)
        glVertexAttribPointer(loc, 3, GL_FLOAT, False, stride, offset)

        glBufferData(GL_ARRAY_BUFFER, data.nbytes, data, GL_STATIC_DRAW)
        glDrawArrays(GL_POINTS, 0, len(data))
        pg.display.flip()

        for event in pg.event.get():
            if event.type == pg.QUIT:
                running = False
if __name__ == "__main__":
    main()
```

Output:


Midpoint Circle - Lab 3 | Nisham Ghimire

2. Write a Program to implement mid- point Ellipse Drawing Algorithm

Ans:

Algorithm

1. Take input radius along x axis and y axis and obtain center of ellipse.
2. Initially, we assume ellipse to be centered at origin and the first point as : (x, y0)= (0, ry). 3.Obtain the initial decision parameter for region 1 as: p10=ry2+1/4rx2-rx 2ry
4. For every xk position in region 1 :

- If p1k<0 then the next point along the is (xk+1 , yk) and p1k+1=p1k+2ry2xk+1+ry2
- Else, the next point is (xk+1, yk-1) 5.And p1k+1=p1k+2ry2xk+1 – 2rx2yk+1+ry2

6. Obtain the initial value in region 2 using the last point (x0, y0) of region 1 as: p20=ry2(x0+1/2)2+rx2 (y0-1)2-rx2ry2
7. At each yk in region 2 starting at k =0 perform the following task.
    - If p2k>0 the next point is (xk, yk-1) and p2k+1=p2k-2rx2yk+1+rx2
    - Else, the next point is (xk+1, yk -1) and p2k+1=p2k+2ry2xk+1 - 2rx2yk+1+rx2
8. Now obtain the symmetric points in the three quadrants and plot the coordinate value as: x=x+xc, y=y+yc
9. Repeat the steps for region 1 until 2ry2x>=2rx2y

Source Code:

```
import ctypes
import numpy as np
from OpenGL.GL import *
from OpenGL.GLU import *
import pygame as pg
from pygame.locals import *

# Define Shaders
vertexShader = """
attribute vec2 position;
void main()
{
  gl_Position = vec4(position, 0.0, 1.0);
}
"""

fragmentShader = """
void main()
{
  gl_FragColor = vec4(1.0,0.0,0.0,1.0);
}
"""


def normalize(xList, yList, resolution):
    xList = [x / resolution for x in xList]
    yList = [y / resolution for y in yList]
```

```
    coordinateList = np.zeros((len(xList), 2))
    i = 0
    for _ in xList:
        coordinateList[i] = [xList[i], yList[i]]
        i += 1
    return coordinateList


def midpoint_ellipse(rx, ry, xc, yc, res):
    x = 0
    y = ry

    x_coordinates = np.array([])
    y_coordinates = np.array([])

    # Initial decision parameter of region 1
    d1 = (ry * ry) - (rx * rx * ry) + (0.25 * rx * rx)
    dx = 2 * ry * ry * x
    dy = 2 * rx * rx * y
    # For region 1
    while dx < dy:
        x_coordinates = np.append(x_coordinates, x + xc)
        x_coordinates = np.append(x_coordinates, -x + xc)
        x_coordinates = np.append(x_coordinates, x + xc)
        x_coordinates = np.append(x_coordinates, -x + xc)
        y_coordinates = np.append(y_coordinates, y + yc)
        y_coordinates = np.append(y_coordinates, y + yc)
        y_coordinates = np.append(y_coordinates, -y + yc)
        y_coordinates = np.append(y_coordinates, -y + yc)

        if d1 < 0:
            x += 1
            dx = dx + (2 * ry * ry)
            d1 = d1 + dx + (ry * ry)
        else:
            x += 1
            y -= 1
            dx = dx + (2 * ry * ry)
            dy = dy - (2 * rx * rx)
            d1 = d1 + dx - dy + (ry * ry)

    # Decision parameter of region 2
    d2 = (
        ((ry * ry) * ((x + 0.5) * (x + 0.5)))
        + ((rx * rx) * ((y - 1) * (y - 1)))
        - (rx * rx * ry * ry)
    )

    # Plotting points of region 2
    while y >= 0:
        x_coordinates = np.append(x_coordinates, x + xc)
        x_coordinates = np.append(x_coordinates, -x + xc)
        x_coordinates = np.append(x_coordinates, x + xc)
        x_coordinates = np.append(x_coordinates, -x + xc)
        y_coordinates = np.append(y_coordinates, y + yc)
        y_coordinates = np.append(y_coordinates, y + yc)
        y_coordinates = np.append(y_coordinates, -y + yc)
        y_coordinates = np.append(y_coordinates, -y + yc)
```

```
        if d2 > 0:
            y -= 1
            dy = dy - (2 * rx * rx)
            d2 = d2 + (rx * rx) - dy
        else:
            y -= 1
            x += 1
            dx = dx + (2 * ry * ry)
            dy = dy - (2 * rx * rx)
            d2 = d2 + dx - dy + (rx * rx)

    return normalize(x_coordinates, y_coordinates, res)


tempData = midpoint_ellipse(800, 400, 0, 0, 1000)
data = np.zeros(int(len(tempData)), [("position", np.float32, 2)])
data["position"] = tempData


def compileShader(source, type):
    shader = glCreateShader(type)
    glShaderSource(shader, source)

    glCompileShader(shader)
    if not glGetShaderiv(shader, GL_COMPILE_STATUS):
        error = glGetShaderInfoLog(shader).decode()
        print(error)
        raise RuntimeError(f"{source} shader compilation error")
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def createProgram(vertex, fragment):
    program = glCreateProgram()
    glAttachShader(program, vertex)
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    glLinkProgram(program)
    if not glGetProgramiv(program, GL_LINK_STATUS):
        print(glGetProgramInfoLog(program))
        raise RuntimeError("Error Linking program")

    glDetachShader(program, vertex)
    glDetachShader(program, fragment)

    return program


def main():
    running = True
    while running:
        width, height = 800, 800
        pg.init()
        pg.display.set_mode((width, height), DOUBLEBUF | OPENGL | GL_RGBA)
        pg.display.set_caption("Midpoint Ellipse - Lab 3 | Nisham Ghimire")
        glViewport(0, 0, width, height)
        # here inti()
        glClear(GL_COLOR_BUFFER_BIT)
        glClearColor(0.0, 0.0, 0.0, 1.0)
```

```
        glLoadIdentity()

        program = createProgram(
            compileShader(vertexShader, GL_VERTEX_SHADER),
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        )

        glUseProgram(program)

        buffer = glGenBuffers(1)
        glBindBuffer(GL_ARRAY_BUFFER, buffer)

        stride = data.strides[0]
        offset = ctypes.c_void_p(0)
        loc = glGetAttribLocation(program, "position")
        glEnableVertexAttribArray(loc)
        glBindBuffer(GL_ARRAY_BUFFER, buffer)
        glVertexAttribPointer(loc, 3, GL_FLOAT, False, stride, offset)

        glBufferData(GL_ARRAY_BUFFER, data.nbytes, data, GL_STATIC_DRAW)
        glDrawArrays(GL_POINTS, 0, len(data))
        pg.display.flip()

        for event in pg.event.get():
            if event.type == pg.QUIT:
                running = False


if __name__ == "__main__":
    main()
```
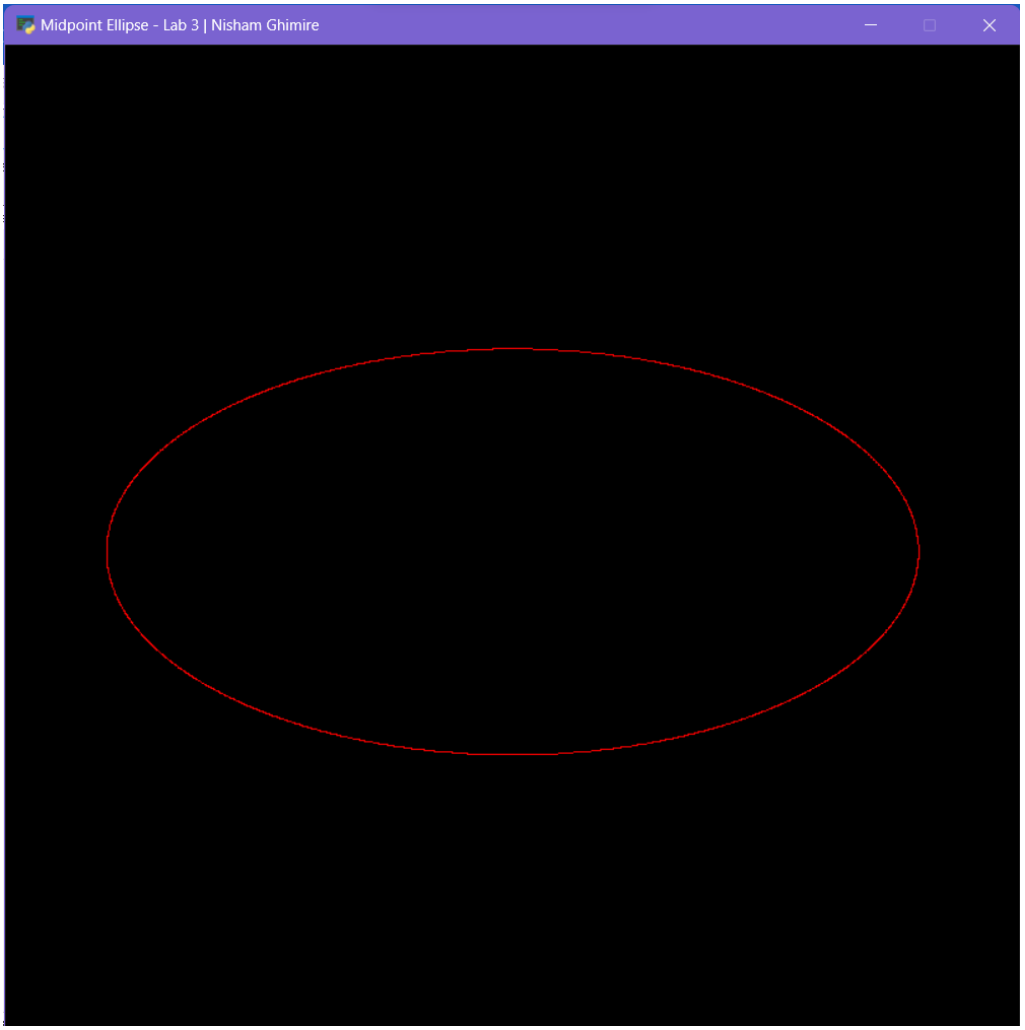

Output:



Conclusion:

After the completion of this lab, I learned how to draw a circle using mid-point circle algorithm and ellipse using mid-point ellipse algorithm by the use of python, Opengl APIs for python, and pygame for window creation.