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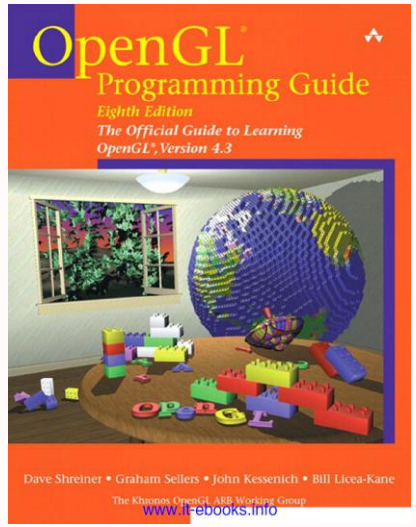
References

- *Lab Lectures, Computer Graphics, Taif University, Faculty Of Computers And Information Technology, TA. Maha Thafar &TA. Haifa Alshehri, TA.Sohair Soliman & L.Shakila Bano.*
- *OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 4.3, 8th edition, Dave Shreiner, Graham Sellers, John Kessenich, Bill Licea-Kane & The Khronos OpenGL ARB Working Group, Addison-Wesley.*



Lecture Five

Drawing Circles and Ellipse using OpenGL

content

circles in OpenGL

- A **circle** is a simple ***shape*** of ***Euclidean geometry*** consisting of those ***points*** which are the same ***distance*** from a given point called the ***center***.
- The common distance of the points of a circle from its center is called its ***radius***.

There are several way to draw a circle:

1) Draw a circle by algorithms:

- Simple circle drawing algorithm
- Midpoint Circle Algorithm.
- Bresenham's Circle Algorithm.
- DDA Algorithm.

2) Draw a circle by arithmetic equations:

- Trigonometric functions.

circles in OpenGL

- **Draw a circle by algorithms:**

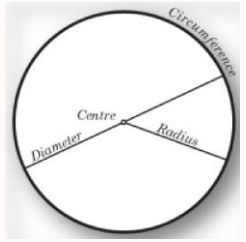
1. Simple circle drawing algorithm

- In an x-y **Coordinate System**, the circle with center (*a*, *b*) and radius *r* is the set of all points(x, y) such as the equation:

$$(x-a)^2+(y-b)^2= r^2$$

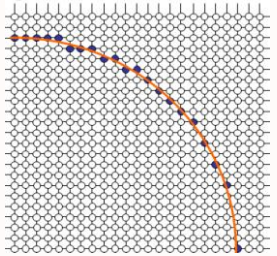
- If the circle is centered at the origin (0, 0), then the equation simplifies to:

$$x^2 + y^2 = r^2$$



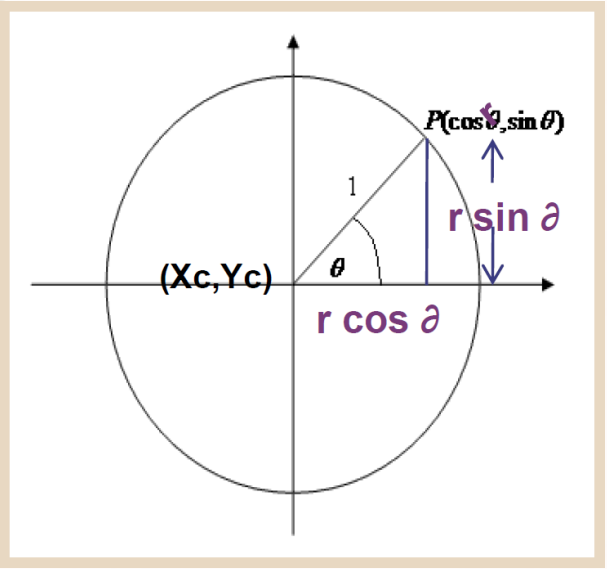
- where: **x= x coordinate ,y= y coordinate ,r = radius**
- **Note:** This method : **not very GOOD** because:
  1. the resulting circle has large gaps.
  2. the calculations are not very efficient with **square root** operations.

$$y = \mp\sqrt{r^2 - x^2}$$



circles in OpenGL

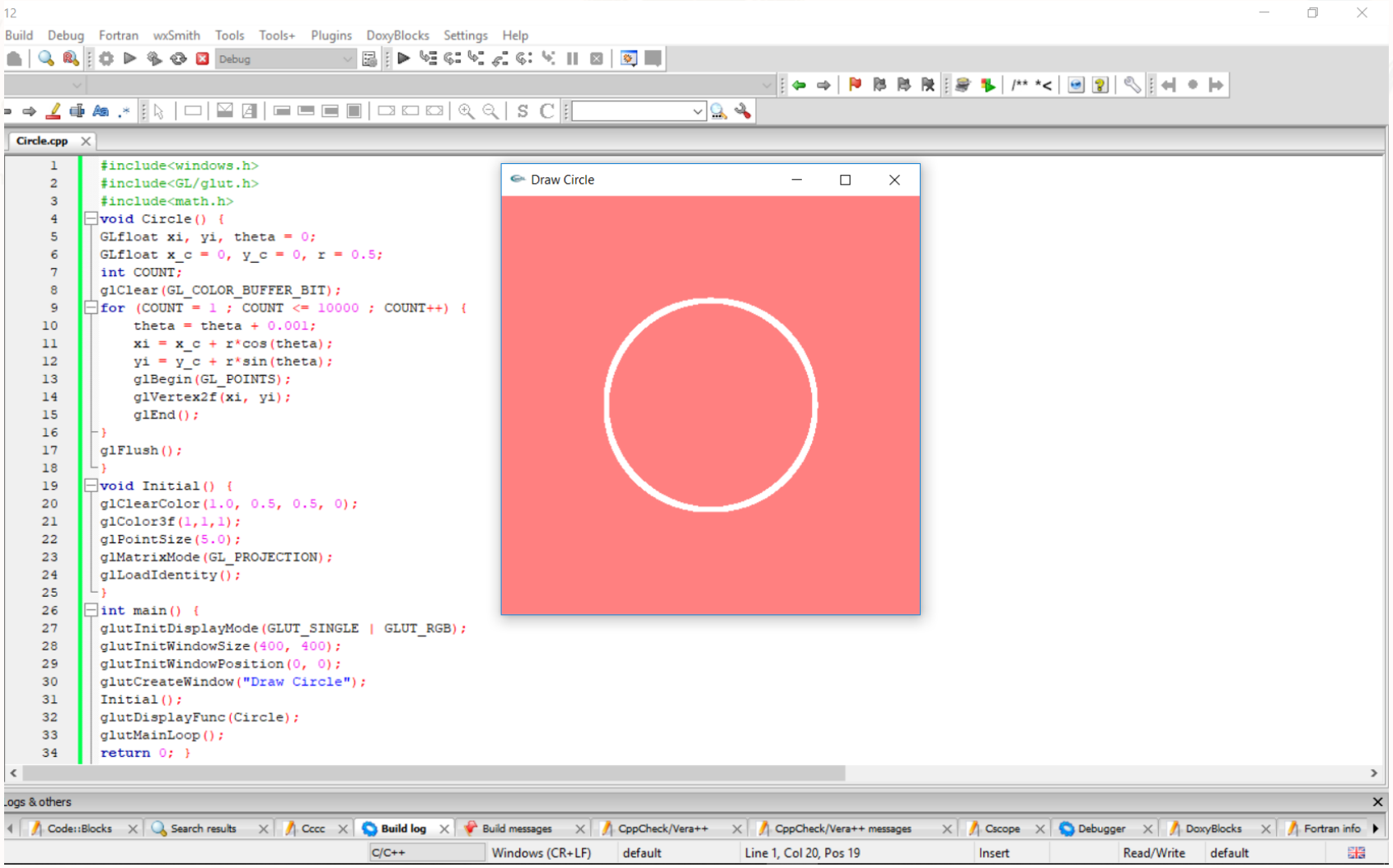
- **Draw a circle by arithmetic equations:**
  - ***Using the*** **trigonometric functions:**
  - If the circle is centered at the origin (Xc, Yc):
    - $\sin\theta = (Y - Yc)/r \quad \rightarrow \quad Y = YC + r * \sin\theta$
    - $\cos\theta = (X - Xc)/r \quad \rightarrow \quad X = XC + r * \cos\theta$
  - If the circle is centered at the origin (0, 0), then the equation simplifies to
    - $Y = r \sin\theta$
    - $X = r \cos\theta$



Draw circle using OpenGL

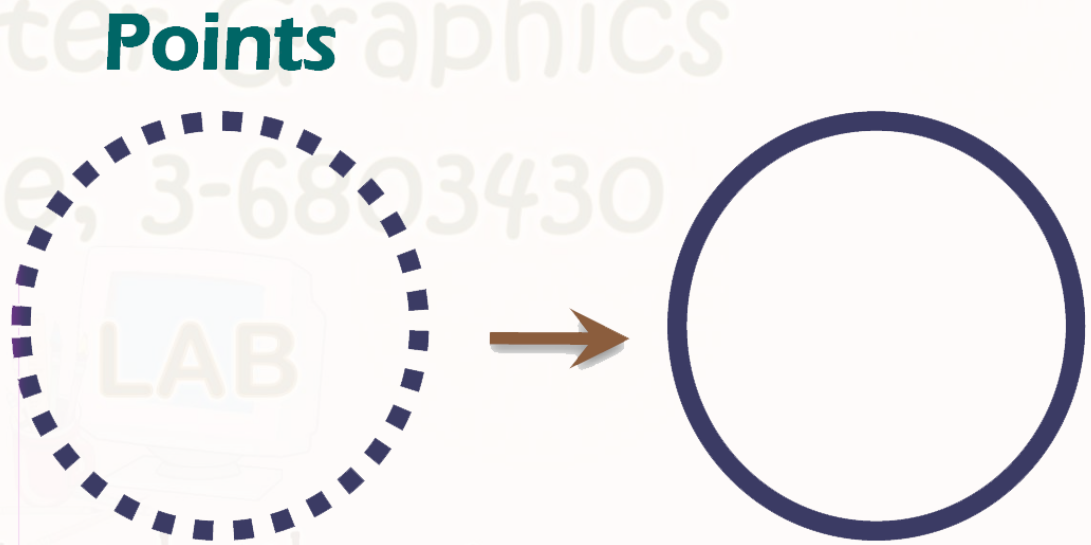
```
#include<windows.h>
#include<GL/glut.h>
#include<math.h>
void Circle() {
GLfloat xi, yi, theta = 0;
GLfloat x_c = 0, y_c = 0, r = 0.5;
int COUNT;
glClear(GL_COLOR_BUFFER_BIT);
for (COUNT = 1 ; COUNT <= 10000 ; COUNT++) {
    theta = theta + 0.001;
    xi = x_c + r*cos(theta);
    yi = y_c + r*sin(theta);
    glBegin(GL_POINTS);
    glVertex2f(xi, yi);
    glEnd();
}
glFlush();
}
void Initial() {
glClearColor(1.0, 0.5, 0.5, 0);
glColor3f(1,1,1);
glPointSize(5.0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw Circle");
Initial();
glutDisplayFunc(Circle);
glutMainLoop();
return 0; }
```

Draw circle using OpenGL



Draw circle using OpenGL

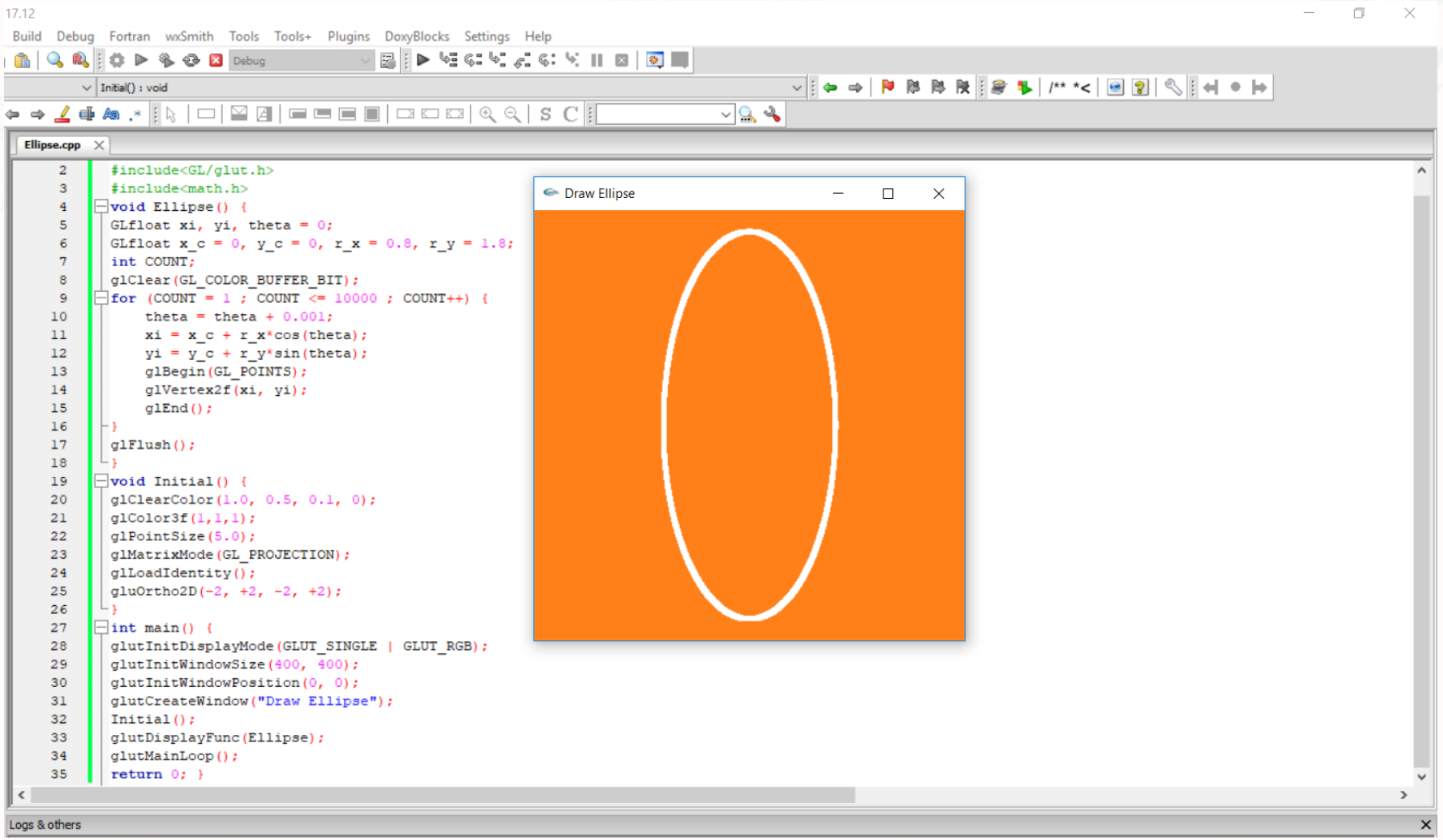
- Note: This program to Draw a circle in OpenGL:
- By draw a large number of points near each other inside loop and this points draw a circle as the following figure:



Draw Ellipse using OpenGL

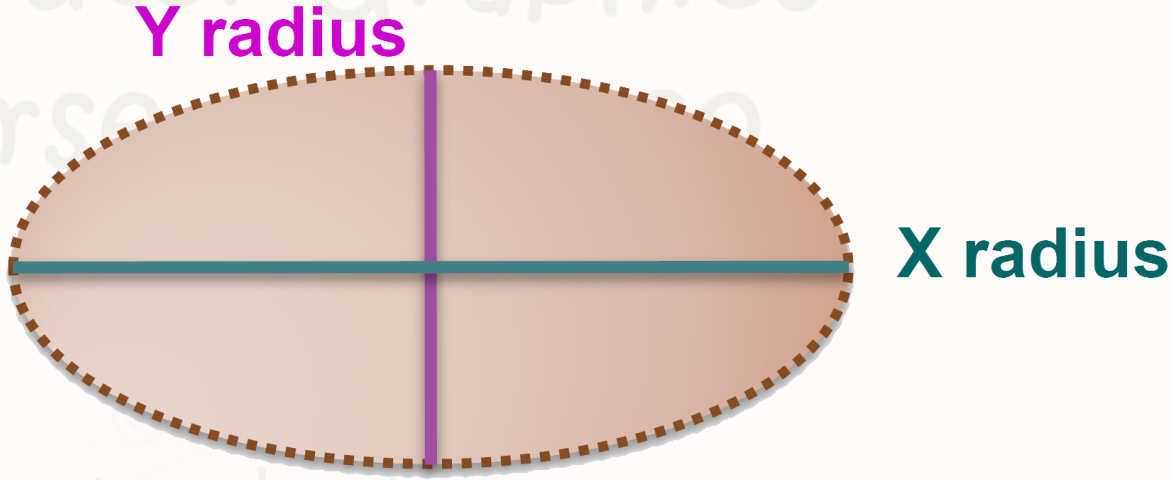
```
#include<windows.h>
#include<GL/glut.h>
#include<math.h>
void Ellipse() {
GLfloat xi, yi, theta = 0;
GLfloat x_c = 0, y_c = 0, r_x = 0.8, r_y = 1.8;
int COUNT;
glClear(GL_COLOR_BUFFER_BIT);
for (COUNT = 1 ; COUNT <= 10000 ; COUNT++) {
    theta = theta + 0.001;
    xi = x_c + r_x*cos(theta);
    yi = y_c + r_y*sin(theta);
    glBegin(GL_POINTS);
    glVertex2f(xi, yi);
    glEnd();
}
glFlush();
}
void Initial() {
glClearColor(1.0, 0.5, 0.1, 0);
glColor3f(1,1,1);
glPointSize(5.0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(-2, +2, -2, +2);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw Ellipse");
Initial();
glutDisplayFunc(Ellipse);
glutMainLoop();
return 0; }
```

Draw Ellipse using OpenGL

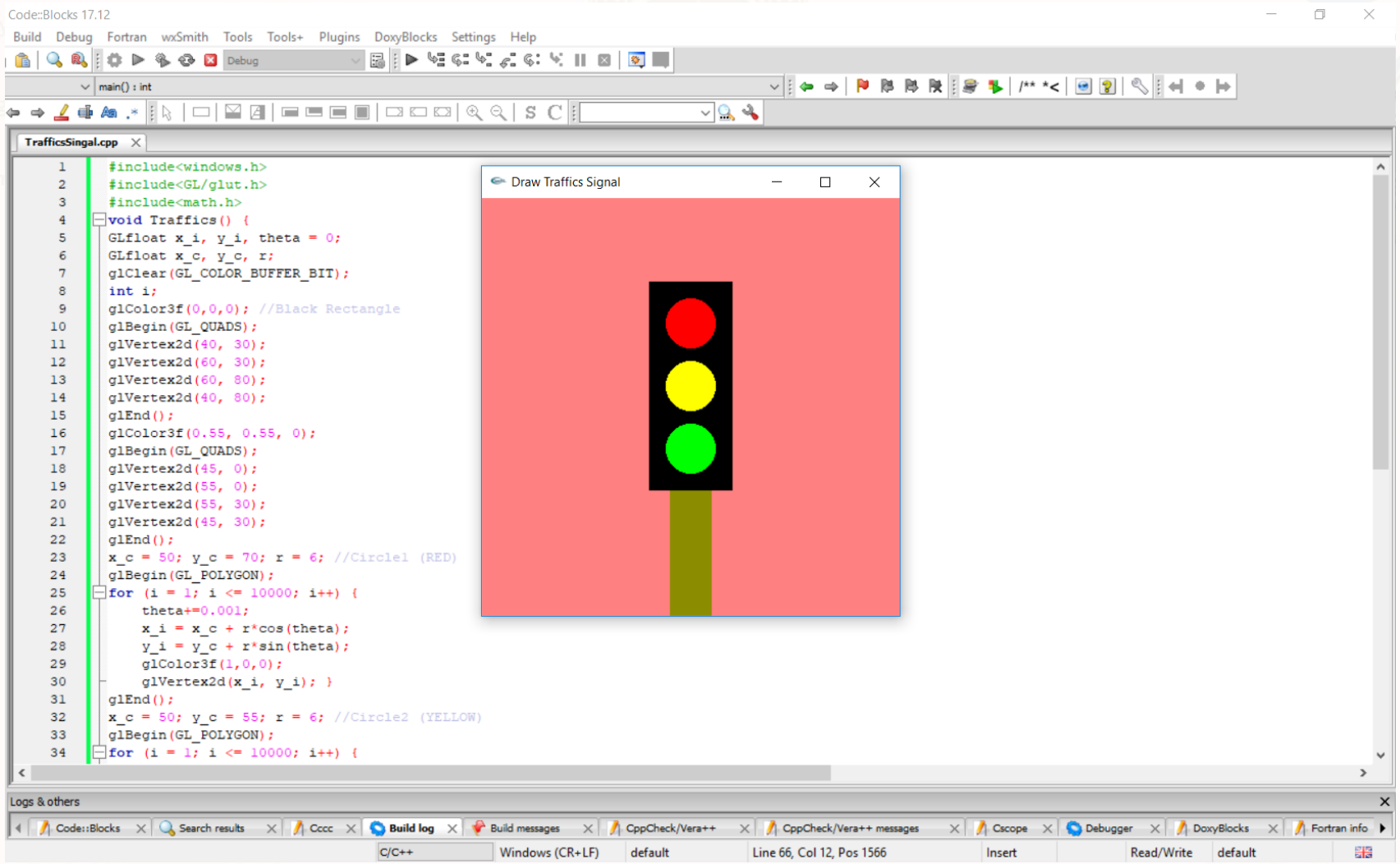


Draw Ellipse using OpenGL

- **NOTE:**
  - To draw ellipse:
  - The different between circle & ellipse only in radius, in ellipse we have 2 radius:
    1. X radius.
    2. and Y radius.



Draw Graphics Signal using OpenGL



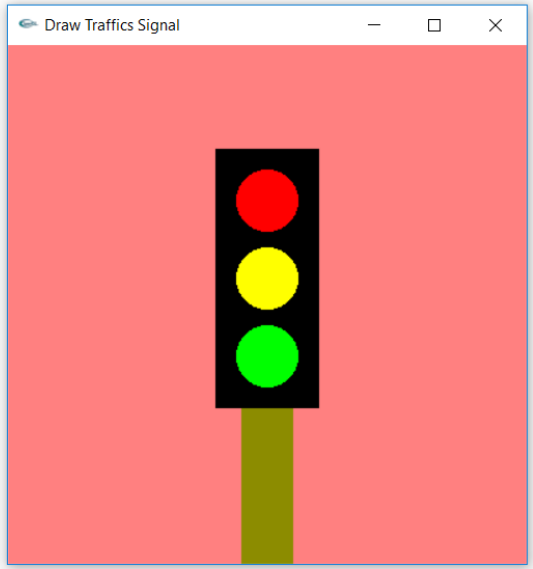
Draw Graphics Signal using OpenGL

Code::Blocks 17.12

Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help

TrafficsSingal.cpp

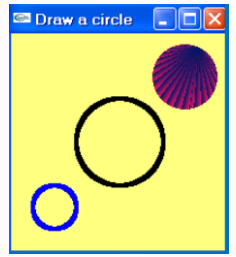
```
30      glVertex2d(x_i, y_i); }
31  glEnd();
32  x_c = 50; y_c = 55; r = 6; //Circle2 (YELLOW)
33  glBegin(GL_POLYGON);
34  for (i = 1; i <= 10000; i++) {
35      theta+=0.001;
36      x_i = x_c + r*cos(theta);
37      y_i = y_c + r*sin(theta);
38      glColor3f(1,1,0);
39      glVertex2d(x_i, y_i);}
40  glEnd();
41  x_c = 50; y_c = 40; r = 6; //Circle3 (Blue)
42  glBegin(GL_POLYGON);
43  for (i = 1; i <= 10000; i++) {
44      theta+=0.001;
45      x_i = x_c + r*cos(theta);
46      y_i = y_c + r*sin(theta);
47      glColor3f(0,1,0);
48      glVertex2d(x_i, y_i);
49  } glEnd();
50  glFlush(); }
51  void Initial() {
52  glClearColor(1.0, 0.5, 0.5, 0);
53  glMatrixMode(GL_PROJECTION);
54  glLoadIdentity();
55  gluOrtho2D(0, 100, 0, 100);
56  } int main() {
57  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
58  glutInitWindowSize(400, 400);
59  glutInitWindowPosition(0, 0);
60  glutCreateWindow("Draw Traffics Signal");
61  Initial();
62  glutDisplayFunc(Traffics);
63  glutMainLoop();
64  return 0; }
```



Logs & others

Important Notes

- **You can draw a circle by 2 shapes**:
  1. Solid (**Fill) Circle** by use **glBegin(GL_POLYGON**) function and write a for loop inside it as the program(3).
  2. Edge (empty) Circle by use:
    - **glBegin(GL_POINTS**) inside the for loop as program(1).
    - **glBegin(GL_LINE_LOOP)** or **glBegin(GL_LINE_STRIP)** as we
    - Use **glBegin(GL_POLYGON)** with **glPolygonMode(GL_FRONT_AND_BACK, GL_LINE)**



- You can use **Stipple pattern (lines, polygons)** with draw a circle.
- You can draw one circle by **multiple colors** using: **glColor3f(1, V, 200)** or **glColor3ub(V1 , V2, V3)** functions inside for loop and use also variables in this function as the figure.
- You can draw a circle in any **place** by change the center point(Xc , Yc).
- You can draw a circle by any **size** by change **radius** value.

Excercise

- **Draw a Circle that satisfies the following specifications:**
  - **Point Size= 16.**
  - **X = x_c = 0, Y = y_c = 0, Radius = 0.8, and theta = 0.**
  - **Circle Color Line = Blue.**
  - **Background Color = Yellow.**
  - **Window Title Bar = “My Circle”.**

وصلى الله وبارك على نبينا محمد

The End Summary of Lecture Five

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