实验 4 交互与动画 II

【实验目的】
1.掌握基本交互式程序的编程方法。
2.掌握基本动画程序的编程方法。

【实验原理】

介绍交互与动画相关的新的 OpenGL 函数（参考 PPT 和课本等资料）：
如窗口改变回调函数、重绘回调函数、单双缓存技术等。

【实验内容】
1.将正方形旋转的程序 squareRotate.c 改成正六边形旋转的程序。

将 display 函数中的顶点确定段改成下面这样：

```
glVertex2f(cos(theta * DEGREES_TO_RADIANS),
               sin(theta * DEGREES_TO_RADIANS))
glVertex2f(cos(pi / 3 + theta * DEGREES_TO_RADIANS),
               sin(pi / 3 + theta * DEGREES_TO_RADIANS))
glVertex2f(cos(2 * pi / 3 + theta * DEGREES_TO_RADIANS),
               sin(2 * pi / 3 + theta * DEGREES_TO_RADIANS))
glVertex2f(cos(2 * pi / 3 + theta * DEGREES_TO_RADIANS),
               sin(2 * pi / 3 + theta * DEGREES_TO_RADIANS))
glVertex2f(-cos(theta * DEGREES_TO_RADIANS),
               -sin(theta * DEGREES_TO_RADIANS))
glVertex2f(cos(-2 * pi / 3 + theta * DEGREES_TO_RADIANS),
               sin(-2 * pi / 3 + theta * DEGREES_TO_RADIANS))
glVertex2f(cos( -1 * pi / 3 + theta * DEGREES_TO_RADIANS),
               sin( -1 * pi / 3 + theta * DEGREES_TO_RADIANS))
```

即可实现正六边形的旋转

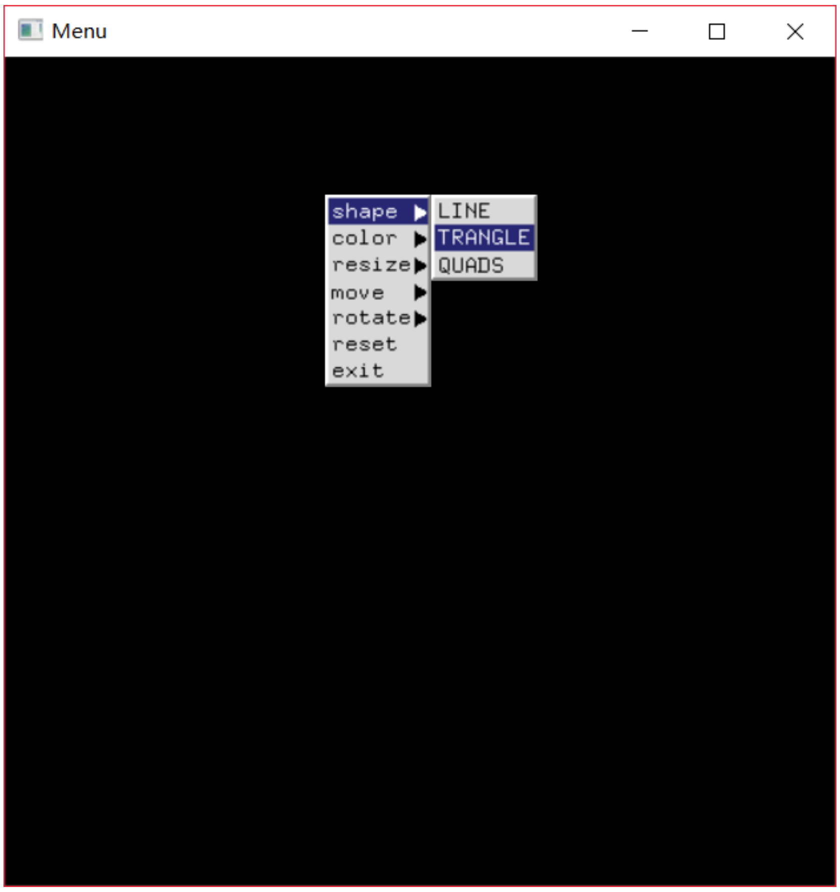
2.创建一个绘图程序，使得可用鼠标来创建一些简单的形状，如线段，三角形，矩形，并可通过菜单来实现下列功能。要求：
（1）可改变形状的颜色。
（2）可改变形状的大小。
（3）可移动形状。
（4）可旋转形状。
（5）你能想到的任何功能。

算法概括：

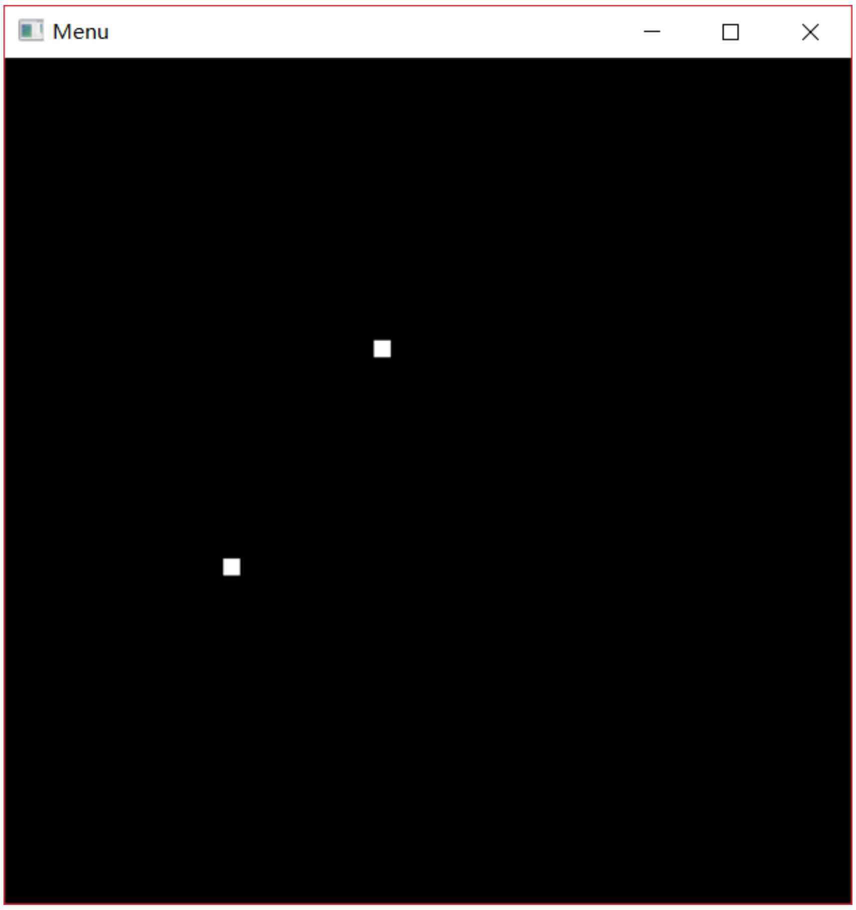
使用全局变量 shape_mode 记录选择绘制的图形，全局变量 vexs 保存顶点信息，以完成旋转、平移后的重绘操作。

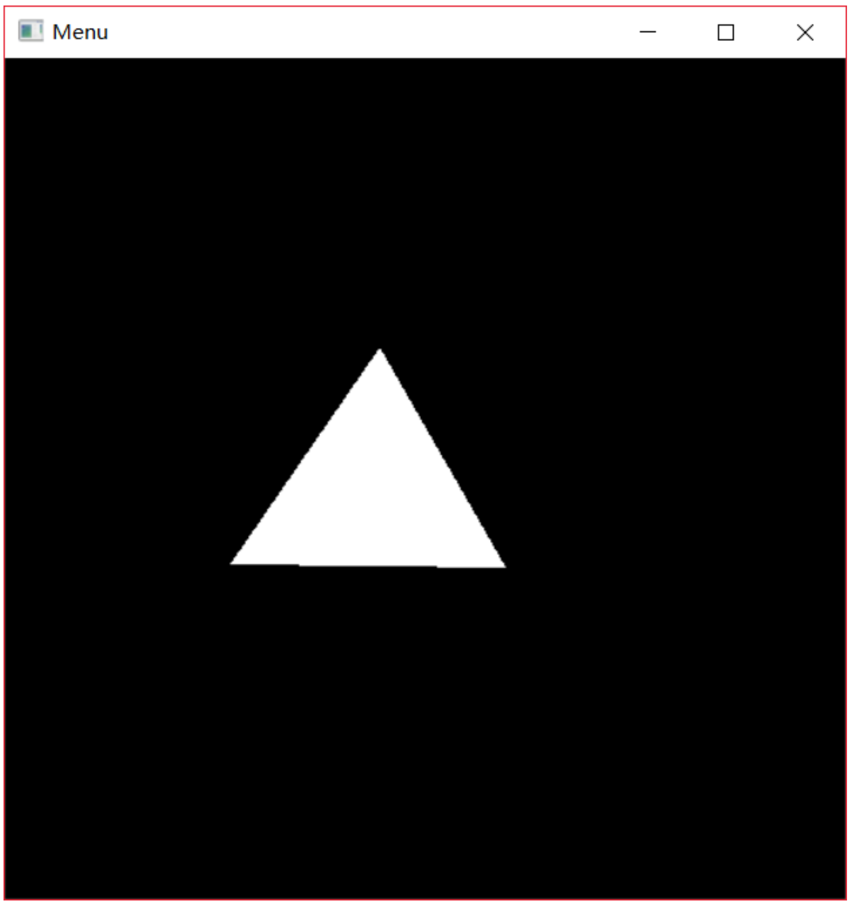
演示：

1、生成图形：

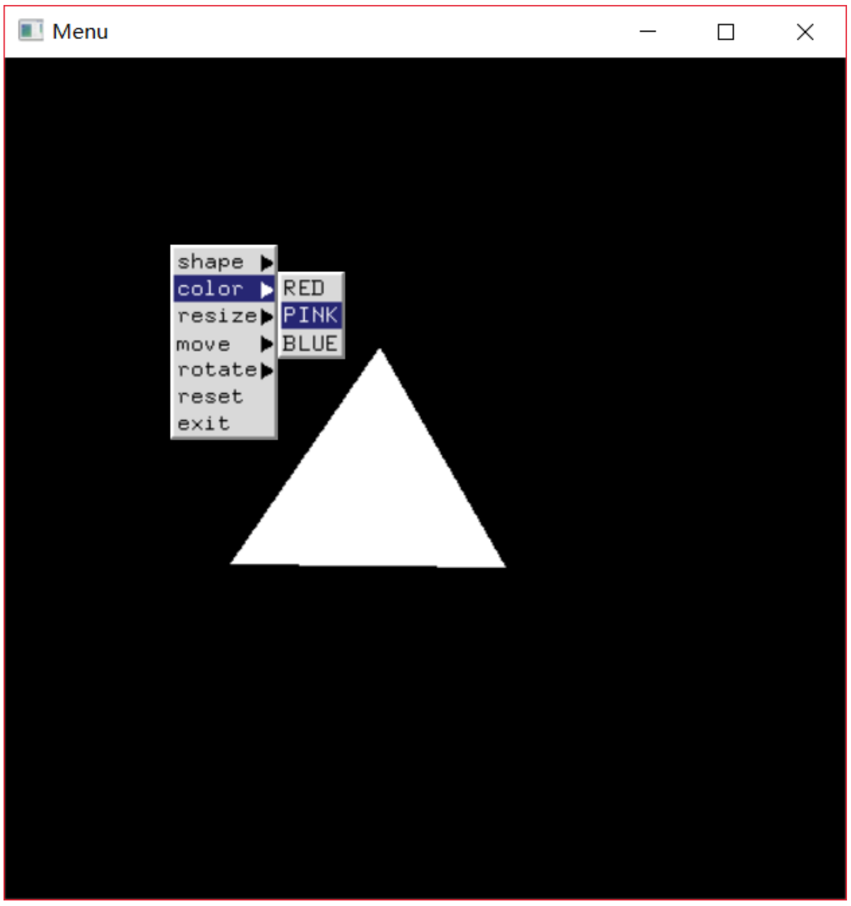


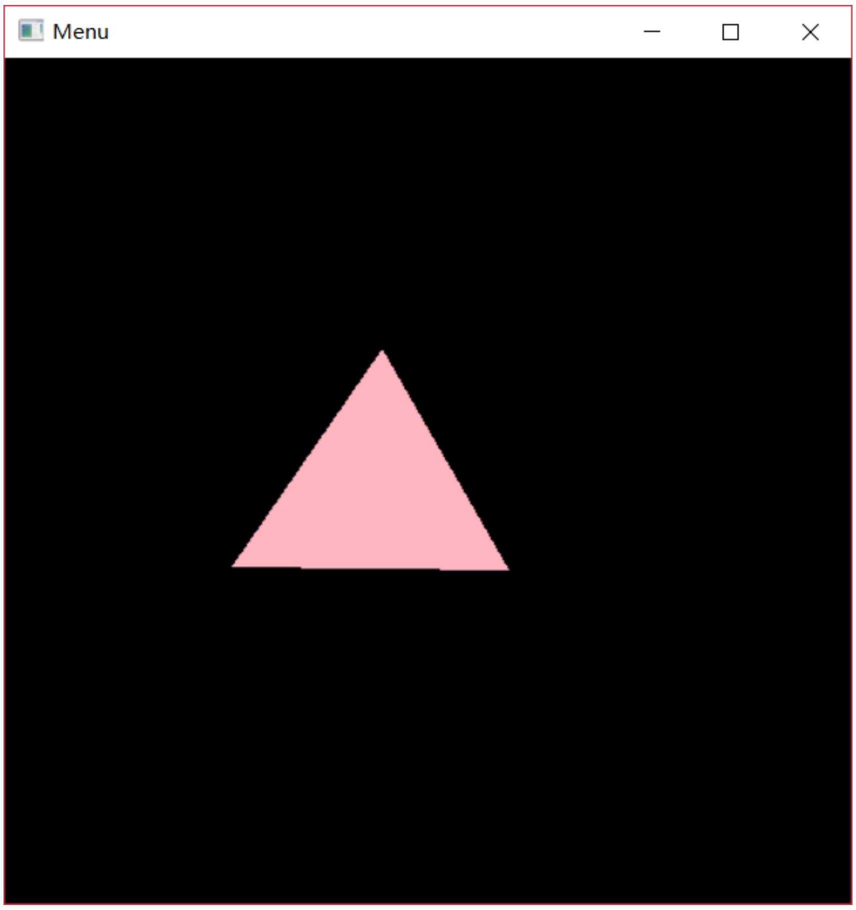
以三角形为例，使用鼠标依次确定三个顶点：



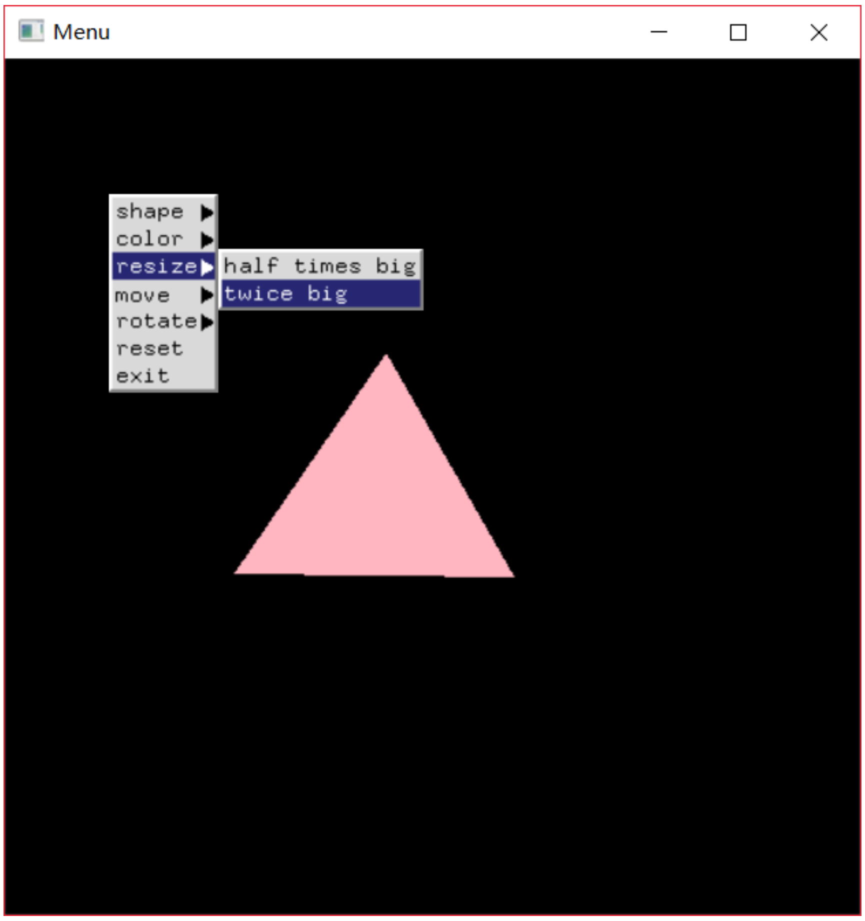

Menu

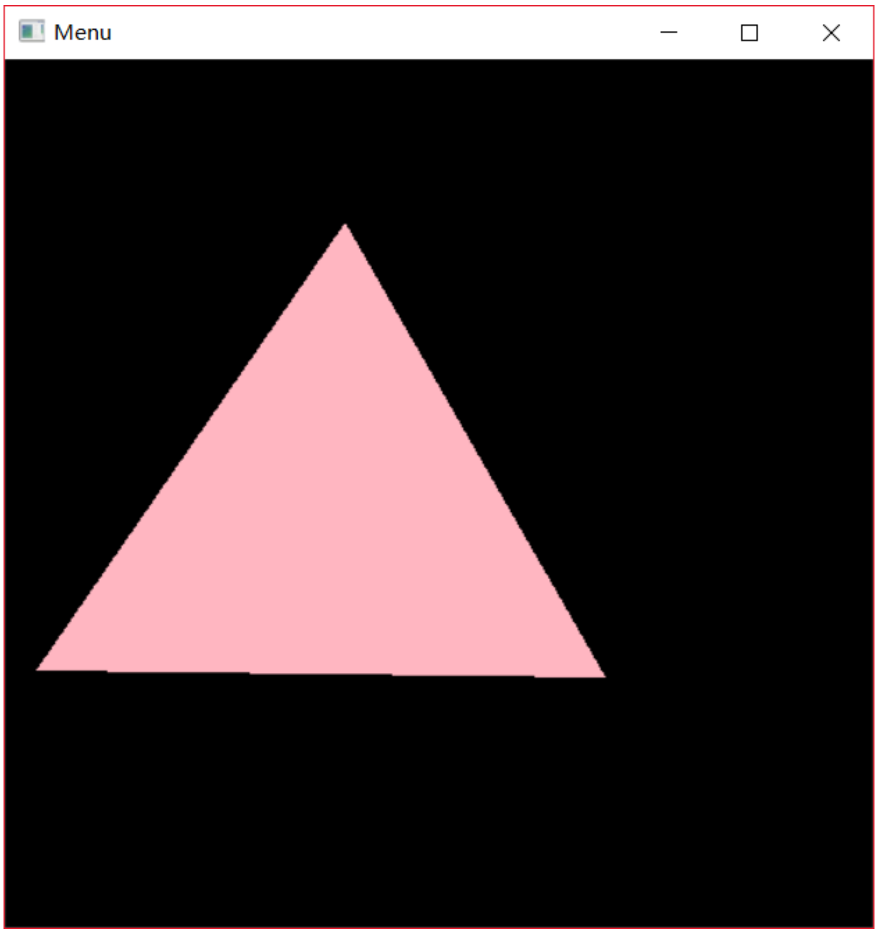
2、更改颜色（以粉色为例）：


Menu
shape
color
resize
move
rotate
reset
exit
RED
PINK
BLUE

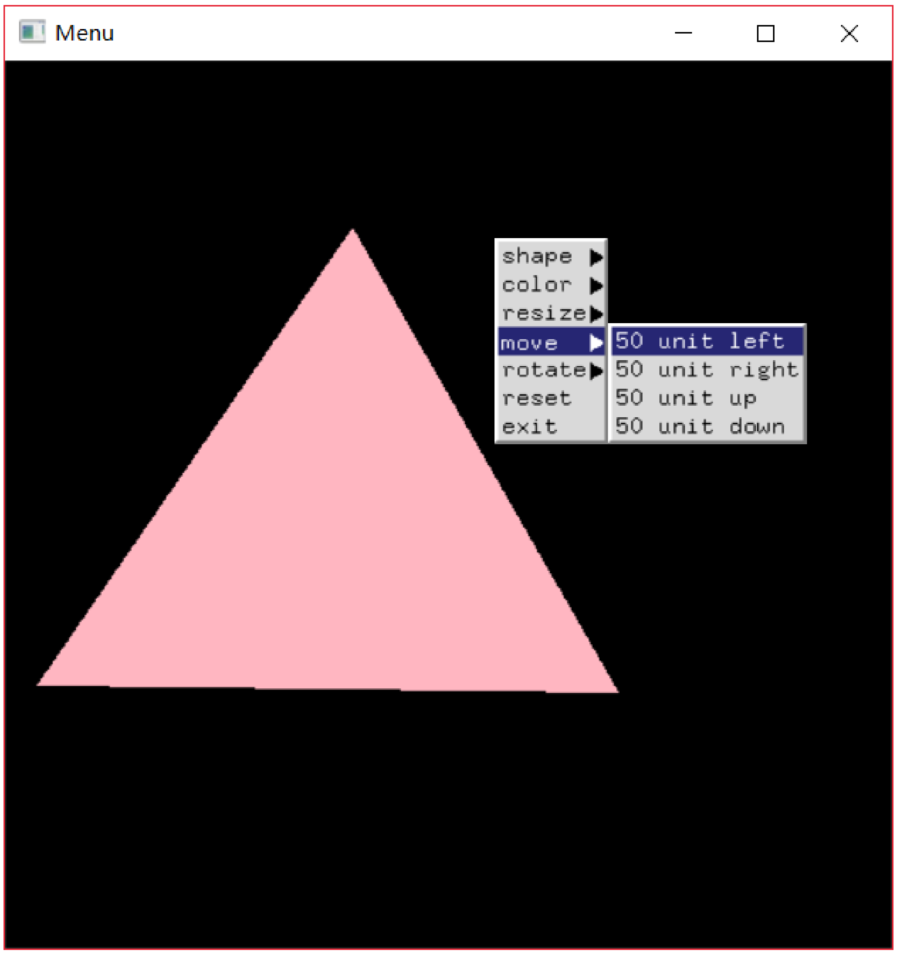

Menu

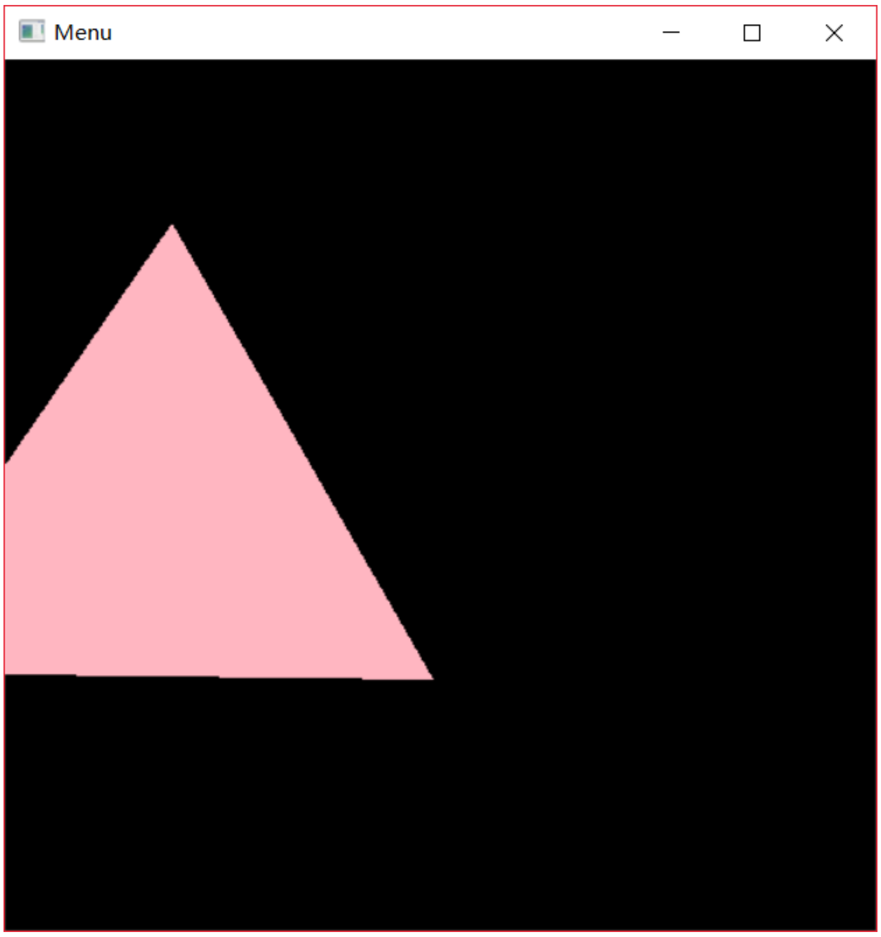
3、缩放（以放大两倍为例）：

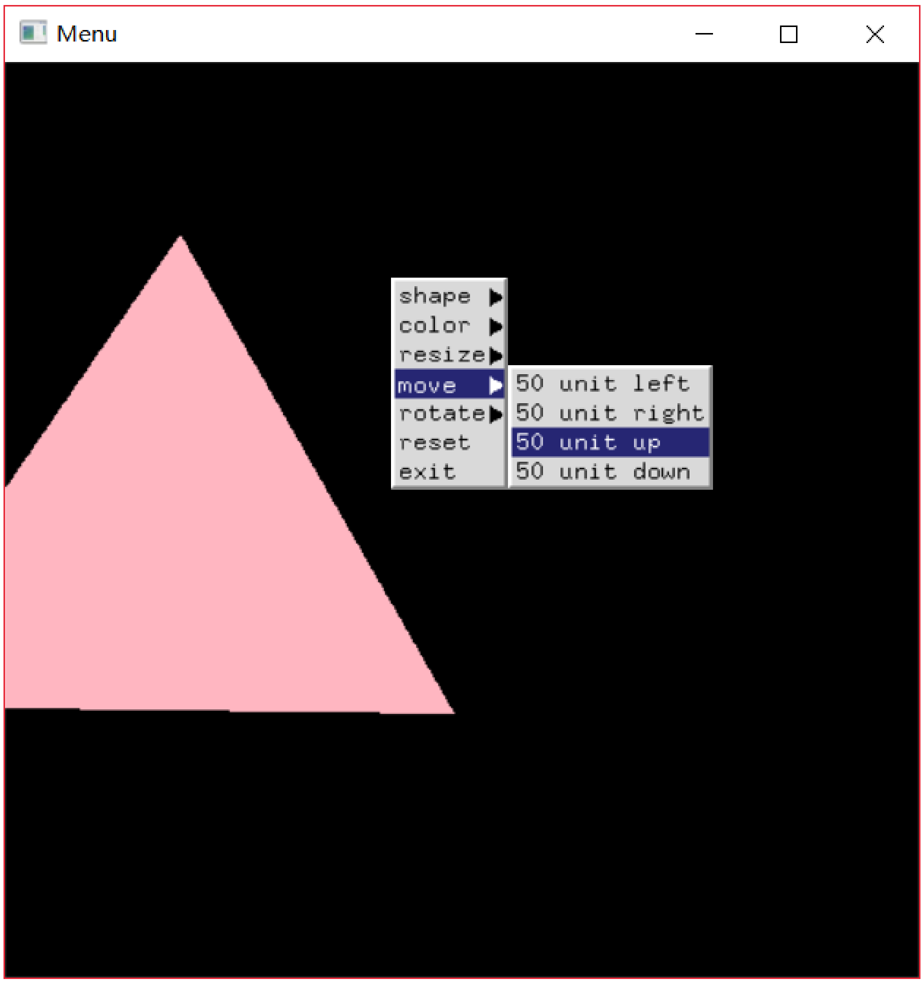

Menu
shape
color
resize
move
rotate
reset
exit
half times big
twice big

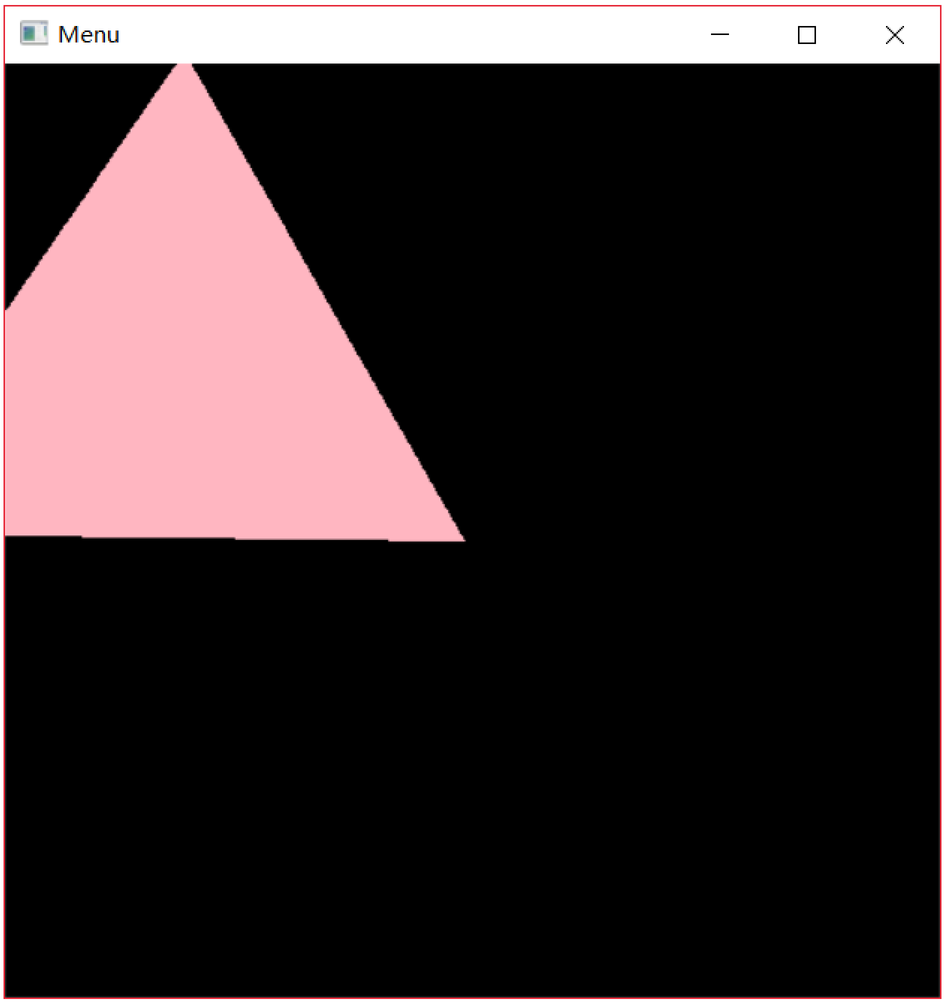


4、平移（以向左平移50个单位，再向上平移50单位为例）:

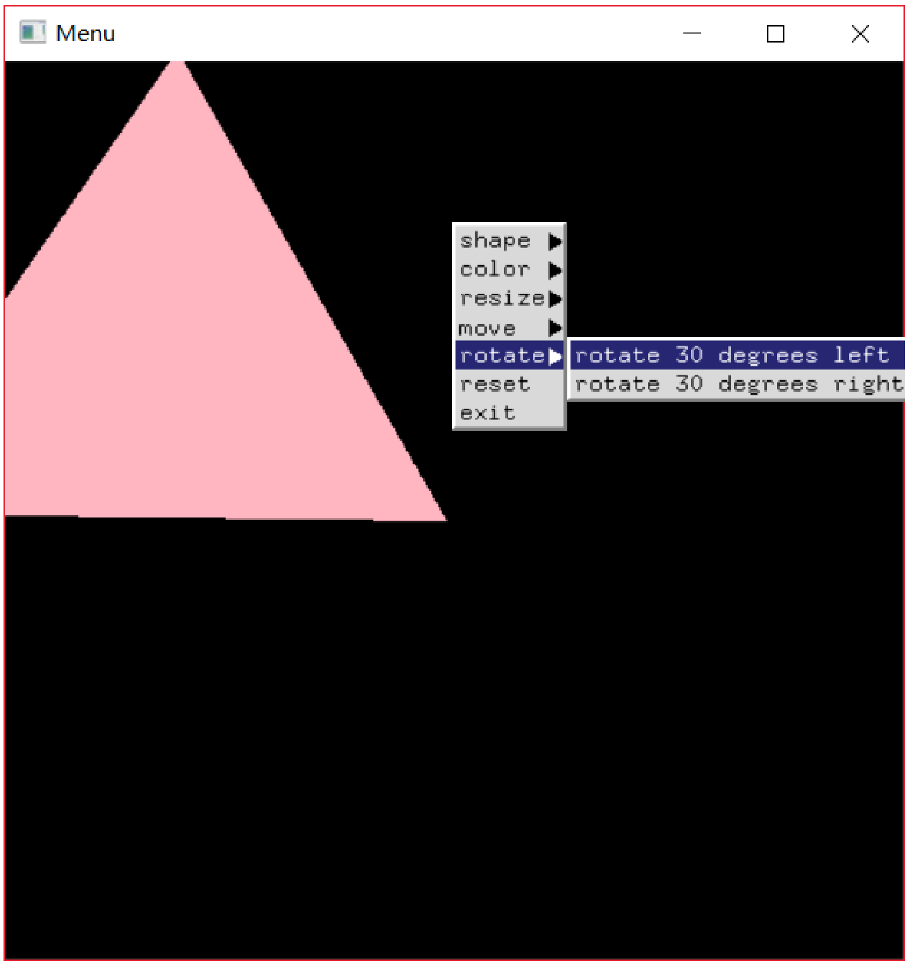


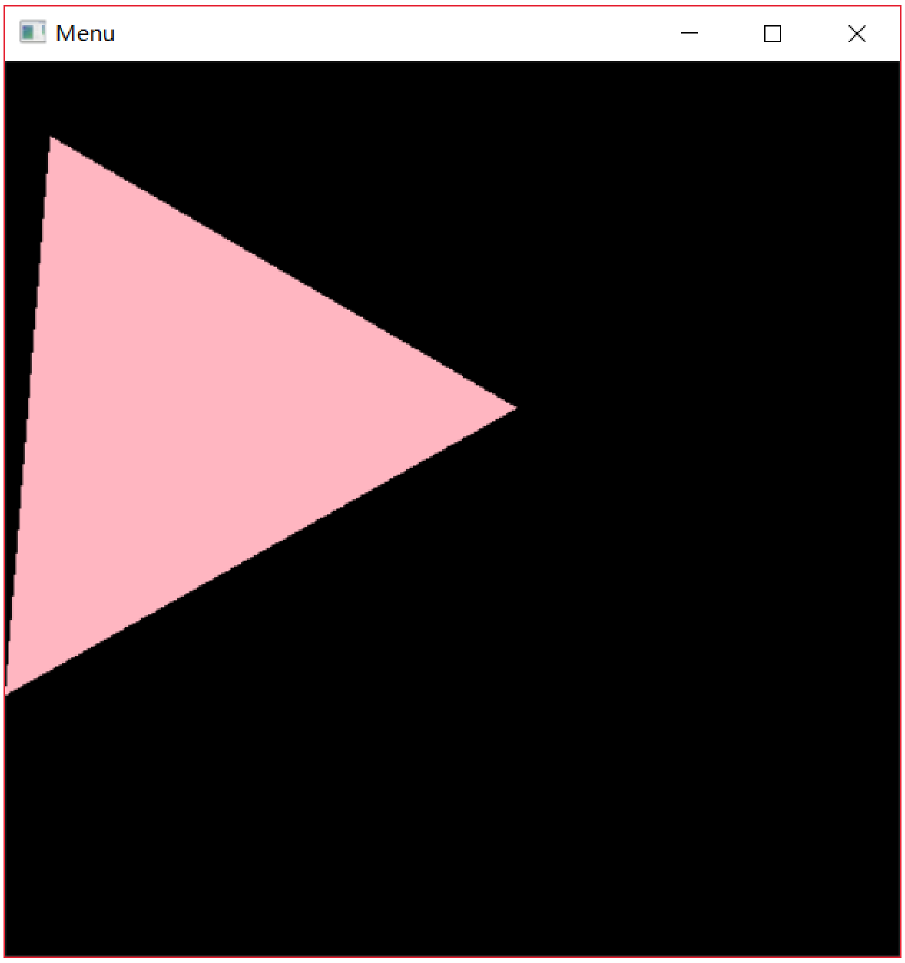

Menu

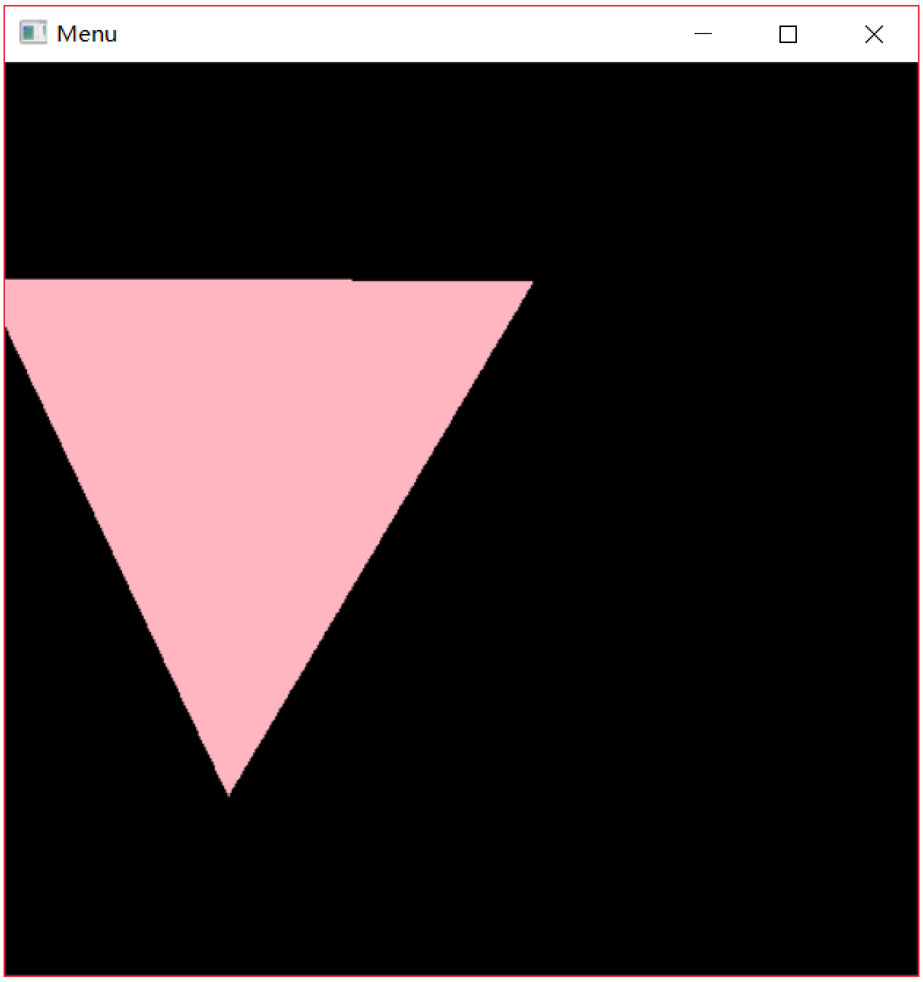

Menu
shape
color
resize
move
rotate
reset
exit
50 unit left
50 unit right
50 unit up
50 unit down



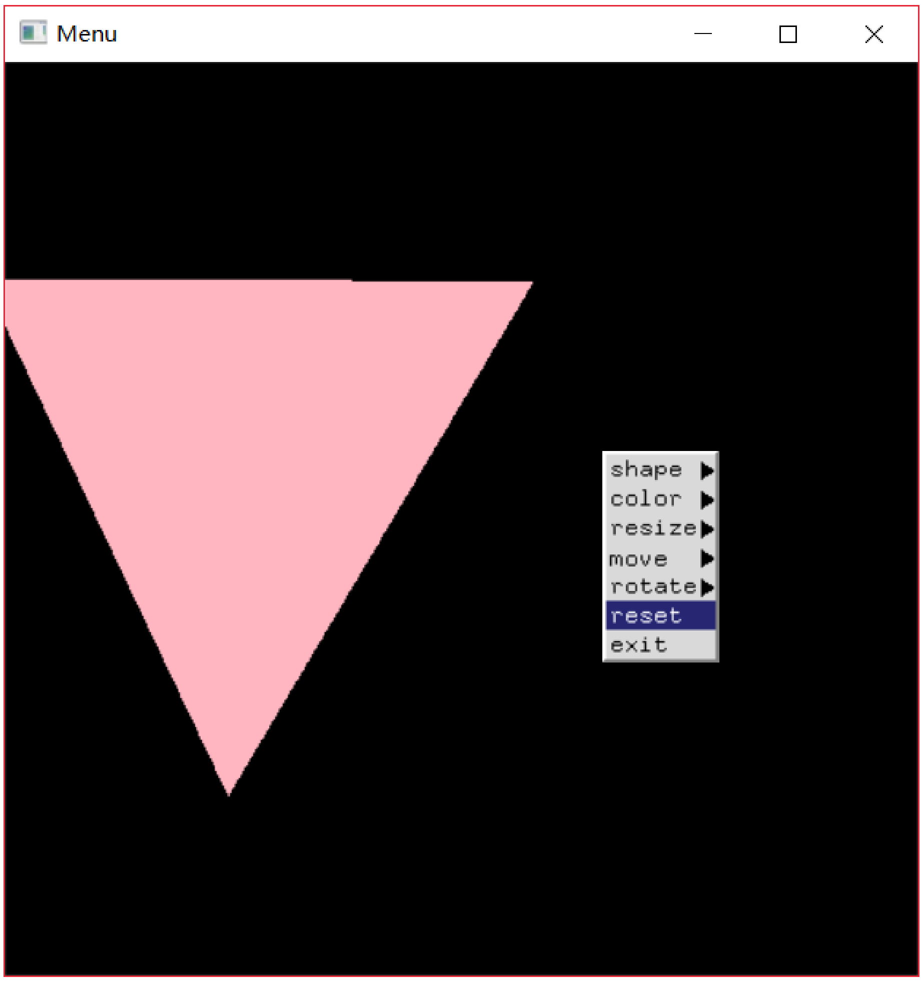
5、旋转（以连续两次向左旋转30度为例）：

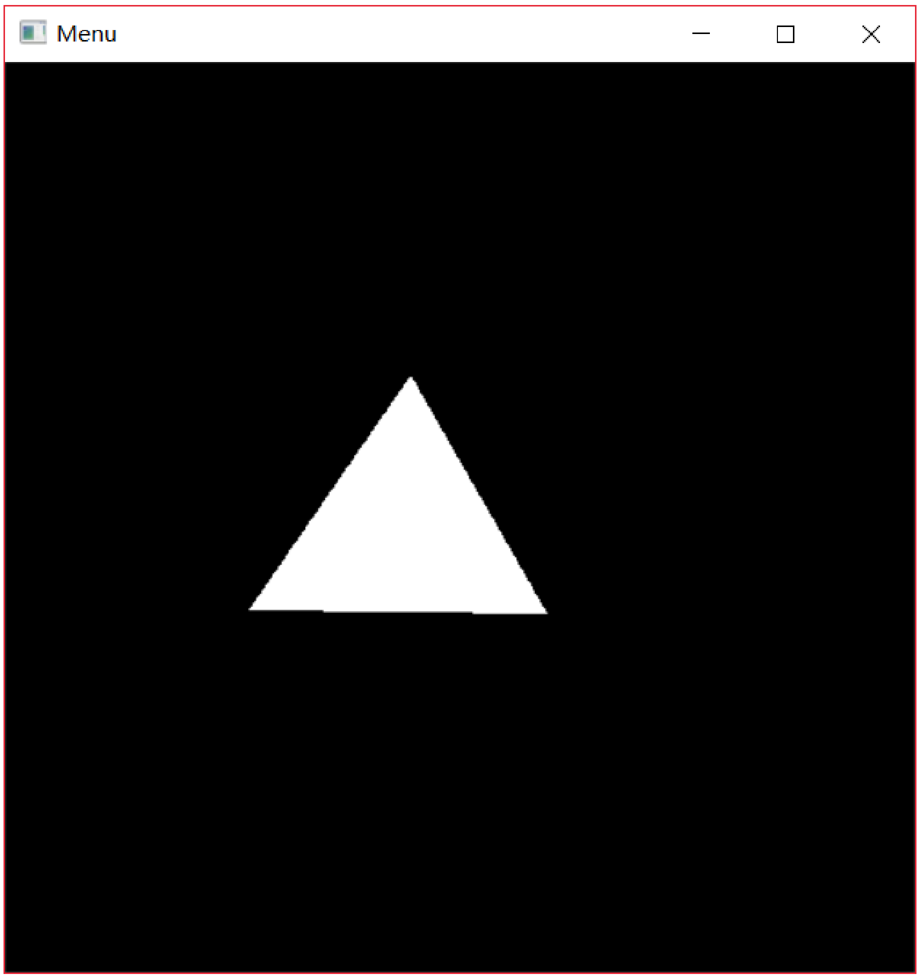




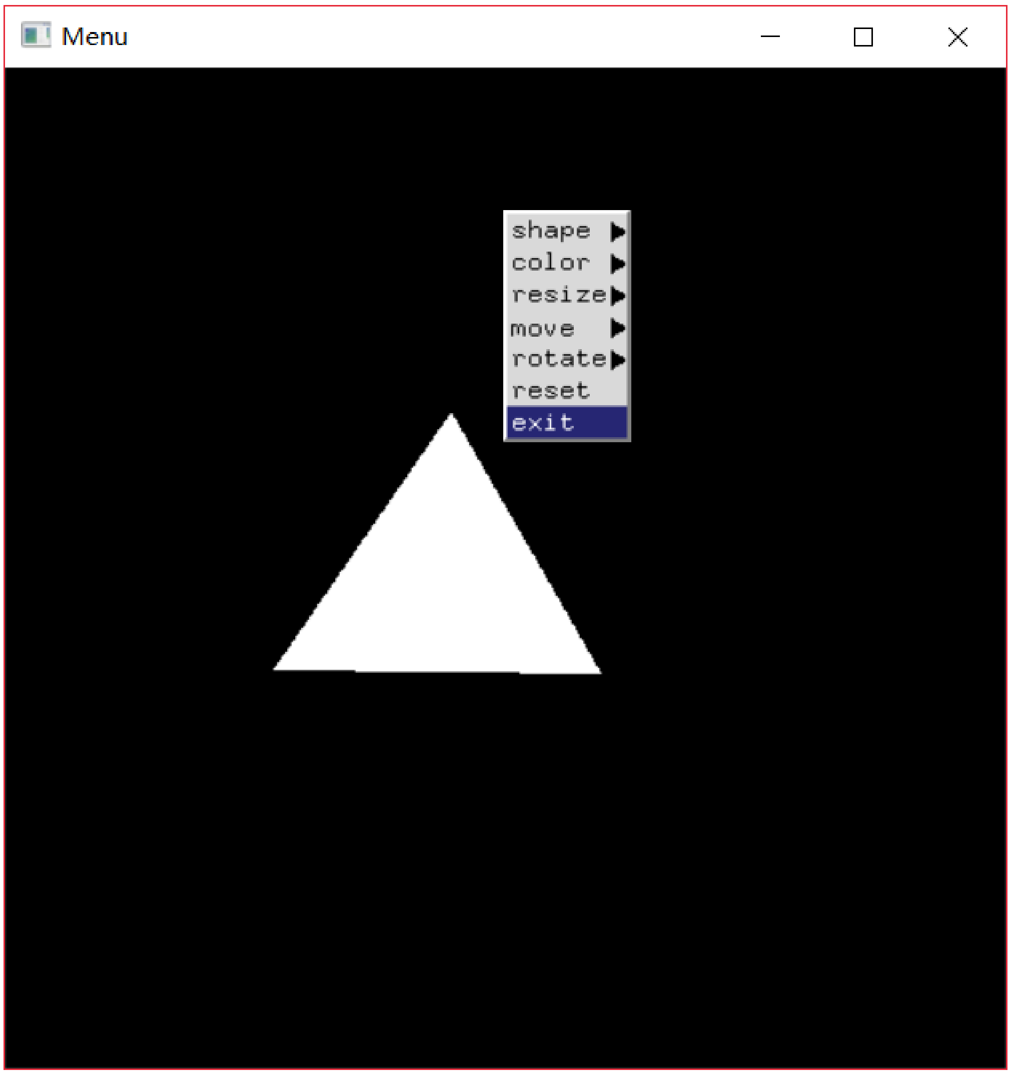


6、图形复位，恢复初始大小、位置和颜色：


Menu
shape
color
resize
move
rotate
reset
exit


Menu

7、终止程序：



选择该选项后程序将终止运行

其他效果（比如生成矩形和线段、缩小1/2、向右平移等）没有在此展示，但经测试，均可正常运行。

附：Python版源代码：

```
from OpenGL.GL import *
from OpenGL.GLUT import *

# 全局变量记录形状选择
shape_mode = 0
# status 为0 时不绘图，为1 时绘图
status = -1
vexs = []

def display():

    glClearColor(0.0, 0.0, 0.0, 1)
    glMatrixMode(GL_PROJECTION)
    glLoadIdentity()
    glOrtho(-250, 250, -250, 250, -1, 1)


def process_menu_events(value):
    ''' 处理部分菜单命令 '''
    global color_mode
    if value == 0:

        exit()

    if value == 1:

        glLoadIdentity()
        glOrtho(-250, 250, -250, 250, -1, 1)
        glColor3f(1.0, 1.0, 1.0)
        draw_figure(vexs)


def draw_point(x, y):
    ''' 绘制一个点 '''
    glPointSize(10)
    glBegin(GL_POINTS)
    glVertex2f(x, y)
    glEnd()
    glFlush()


def draw_figure(vexs):
    ''' 根据 vexs 列表和 shape_mode 绘制图形 '''
    glClear(GL_COLOR_BUFFER_BIT)
    if shape_mode == 1:

        glLineWidth(5)
        glBegin(GL_LINES)
        glVertex2f(vexs[0]['x'], vexs[0]['y'])
        glVertex2f(vexs[1]['x'], vexs[1]['y'])

    elif shape_mode == 2:

        glBegin(GL_TRIANGLES)
        glVertex2f(vexs[0]['x'], vexs[0]['y'])
        glVertex2f(vexs[1]['x'], vexs[1]['y'])
        glVertex2f(vexs[2]['x'], vexs[2]['y'])

    elif shape_mode == 3:
```

```python
        glBegin(GL_QUADS)
        glVertex2f(vexs[0]['x'], vexs[0]['y'])
        glVertex2f(vexs[1]['x'], vexs[0]['y'])
        glVertex2f(vexs[1]['x'], vexs[1]['y'])
        glVertex2f(vexs[0]['x'], vexs[1]['y'])

    glEnd()
    glFlush()


def mouse_process(btn, state, x, y):
    ''' 根据鼠标左键确定图形的顶点 '''
    global vexs
    global status
    x = x - 250
    y = 250 - y
    if btn == GLUT_LEFT_BUTTON and state == GLUT_UP and status:

        draw_point(x, y)
        vex = {}
        vex['x'] = x
        vex['y'] = y
        vexs.append(vex)
        if len(vexs) == 2 and (shape_mode == 1 or shape_mode == 3):
            draw_figure(vexs)
            status = 0

        elif len(vexs) == 3 and shape_mode == 2:
            draw_figure(vexs)
            status = 0


def choose_shape_mode(value):
    ''' 选择绘图形状 '''
    global shape_mode
    shape_mode = value
    global status
    status = 1
    vexs.clear()
    glutMouseFunc(mouse_process)


def figure_color_change(value):
    ''' 选择颜色 '''
    global vexs
    if value == 1:
        glColor3ub(255, 48, 48)

    elif value == 2:
        glColor3ub(255, 182, 193)

    elif value == 3:
        glColor3ub(0, 191, 255)

    draw_figure(vexs)


def figure_resize(value):
    ''' 改变图形大小 '''
    if value == 1:
        # 面积缩小为1/2
        glScaled(0.5, 0.5, 0.0)
        draw_figure(vexs)

    if value == 2:
        # 面积扩大为2 倍
        glScaled(2, 2, 0)
        draw_figure(vexs)


def figure_move(value):
    ''' 平移图形 '''
    if value == 1:
        # 向左平移0,2 单位
        glTranslatef(-50, 0.0, 1.0)
        draw_figure(vexs)

    if value == 2:
        # 向右平移50 单位
        glTranslatef(50, 0.0, 1.0)
        draw_figure(vexs)

    if value == 3:
        # 向上平移50 单位
        glTranslatef(0.0, 50, 1.0)
        draw_figure(vexs)

    if value == 4:
        # 向下平移50 单位
        glTranslatef(0.0, -50, 1.0)
        draw_figure(vexs)
```

```
def figure_rotate(value):
    ''' 旋转图形 '''
    if value == 1:
        # 向左旋转30度
        glRotated(30, 0, 0, 1)
        draw_figure(vexs)

    if value == 2:
        # 向右旋转30度
        glRotated(-30, 0, 0, 1)
        draw_figure(vexs)


def creat_menu():
    ''' 创建菜单 '''
    glClear(GL_COLOR_BUFFER_BIT)
    # 子菜单：选择绘图形状
    shape_menu = glutCreateMenu(choose_shape_mode)
    glutAddMenuEntry('LINE', 1)
    glutAddMenuEntry('TRANGLE', 2)
    glutAddMenuEntry('QUADS', 3)
    # 子菜单：选择颜色
    color_menu = glutCreateMenu(figure_color_change)
    glutAddMenuEntry('RED', 1)
    glutAddMenuEntry('PINK', 2)
    glutAddMenuEntry('BLUE', 3)
    # 子菜单：缩放
    resize_menu = glutCreateMenu(figure_resize)
    glutAddMenuEntry('half times big', 1)
    glutAddMenuEntry('twice big', 2)
    # 子菜单：平移
    move_menu = glutCreateMenu(figure_move)
    glutAddMenuEntry('50 unit left', 1)
    glutAddMenuEntry('50 unit right', 2)
    glutAddMenuEntry('50 unit up', 3)
    glutAddMenuEntry('50 unit down', 4)
    # 子菜单：旋转
    rotate_menu = glutCreateMenu(figure_rotate)
    glutAddMenuEntry('rotate 30 degrees left', 1)
    glutAddMenuEntry('rotate 30 degrees right', 2)
    # 创建主菜单
    main_menu = glutCreateMenu(process_menu_events)
    # 将子菜单与主菜单关联
    glutAddSubMenu('shape', shape_menu)
    glutAddSubMenu('color', color_menu)
```

```python
    glutAddSubMenu('resize', resize_menu)
    glutAddSubMenu('move', move_menu)
    glutAddSubMenu('rotate', rotate_menu)
    glutAddMenuEntry('reset', 1)
    glutAddMenuEntry('exit', 0)
    # 菜单调出绑定到鼠标右键
    glutAttachMenu(GLUT_RIGHT_BUTTON)


def main():

    glutInit()
    glutInitDisplayMode(GLUT_SINGLE or GLUT_RGBA)
    glutInitWindowPosition(200, 200)
    glutInitWindowSize(500, 500)
    glutCreateWindow("Menu")
    glutDisplayFunc(display)
    creat_menu()
    glutMainLoop()

main()
```

附：squareRotate.c：

```c
/*
 *  double.c
 *  This program demonstrates double buffering for
 *  flicker-free animation.  The left and middle mouse
 *  buttons start and stop the spinning motion of the square.
 */

#include <stdlib.h>

#ifdef __APPLE__
#include <GLUT/glut.h>
#else
#include <GL/glut.h>
#endif

#include <math.h>

#define DEGREES_TO_RADIANS  3.14159/180.0
```

```
GLfloat theta = 0.0; // 全局变量


void display()
{

   glClear(GL_COLOR_BUFFER_BIT);
   glBegin(GL_POLYGON);
     glVertex2f(cos(theta*DEGREES_TO_RADIANS),sin(theta*DEGREES_TO_RADIANS));
     glVertex2f(-sin(theta*DEGREES_TO_RADIANS),cos(theta*DEGREES_TO_RADIANS));
     glVertex2f(-cos(theta*DEGREES_TO_RADIANS),-sin(theta*DEGREES_TO_RADIANS));
     glVertex2f(sin(theta*DEGREES_TO_RADIANS),-cos(theta*DEGREES_TO_RADIANS));
   glEnd();
   glutSwapBuffers ();
}




void idle()
{
    theta += 2.0;
    if (theta > 360.0) theta -= 360.0;
    glutPostRedisplay();    // 请求重绘
}



void myinit ()
{
    glClearColor (0.0, 0.0, 0.0, 1.0);
    glColor3f (1.0, 1.0, 1.0);
    glShadeModel (GL_FLAT);
}

void mouse(int btn, int state, int x, int y)
{
  if(btn==GLUT_LEFT_BUTTON && state==GLUT_DOWN)
      glutIdleFunc(idle);
  if(glutGetModifiers() == GLUT_ACTIVE_CTRL && btn==GLUT_LEFT_BUTTON && state==GLUT_DOWN)
      glutIdleFunc(NULL);
}

void mykey(unsigned char key, int x, int y)
{
    // 按下Q、q，终止程序
    if(key == 'Q' || key == 'q')       exit(0);
}
```

```
void myReshape(int w, int h)
{
    glViewport(0, 0, w, h);
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    if (w <= h)
    glOrtho (-2.0, 2.0, -2.0*(GLfloat)h/(GLfloat)w,
        2.0*(GLfloat)h/(GLfloat)w, -1.0, 1.0);
    else
    glOrtho (-2.0*(GLfloat)w/(GLfloat)h,
        2.0*(GLfloat)w/(GLfloat)h, -2.0, 2.0, -1.0, 1.0);
    glMatrixMode(GL_MODELVIEW);
    glLoadIdentity ();

}

/*  Main Loop
 *  Open window with initial window size, title bar,
 *  RGBA display mode, and handle input events.
 */
int main(int argc, char** argv)
{

    glutInit(&argc,argv);
    glutInitDisplayMode (GLUT_DOUBLE | GLUT_RGB);
    glutInitWindowPosition(500,0);
    glutCreateWindow("double buffered");
    myinit ();
    glutDisplayFunc(display);
    glutReshapeFunc (myReshape);
    glutIdleFunc (idle);
    glutMouseFunc (mouse);
    glutKeyboardFunc(mykey);

    glutMainLoop();
}
```