COMP4521 EMBEDDED SYSTEMS SOFTWARE

LAB WEEK # 8: GRAPHICS SUPPORT IN ANDROID

INTRODUCTION

In this lab we will learn some graphics related features and functions that are supported in Android. We will use some graphics related functions to enhance our previous application. Thereafter, we will construct a simple ball game using more advanced graphical functions.

OBJECTIVES

- Learn to add special visual effects to layouts using Drawable and objectAnimator.
- Create a simple ball game using View and SurfaceView.

USING THE DRAWABLE CLASS TO ENHANCE THE COURSE INFO APPLICATION

1. Locate the SDK of Android for Eclipse (if necessary).
2. Create an Android Virtual Device (AVD) (if necessary). Make sure to turn on Audio Playback support in the AVD. Edit the AVD if necessary.
3. Import an existing project. We will start from our result of lab week #6.
4. Add a new color in the **/res/values/colors.xml**. The name of the color is orange, and the value is #ffa500.
5. Modify the welcome layout. Four widgets need to be modified in this layout:
   a) Add id and visual style to the second LinearLayout of the file.
   ```
   android:id="@+id/WelcomeInnerLayout"
   android:background="@drawable/back_gradient"
   ```
   b) Add ids to the two ImageViews so that later we can apply animations. The upper one is WelcomeTopImage, the lower one is WelcomeBottomImage.
   c) Delete the TextView displaying the clickpromt string.
6. Modify the list_item.xml. This will affect how the menu items are displayed. Add a style file as the background:
   ```
   android:background="@drawable/menu_selector"
   ```

7. Add visual style files. In /res, create a new folder drawable. Notice that we have already referred to back_gradient.xml in the previous step. Create this file, and use following code as its content. It defines the shape of the area, the visual effect (gradient), the start color and end color, and the direction of gradient. This is an example of the use of a Shape.

```
<shape xmlns:android="http://schemas.android.com/apk/res/android"
   android:shape="rectangle">
   <gradient
      android:startColor="#003366"
      android:endColor="#006699"
      android:angle="270"/>
</shape>
```

8. Create two other style files in **/res/drawable**. The first is highlighted.xml. It's used to define the selected menu items.

```
<shape xmlns:android="http://schemas.android.com/apk/res/android"
   android:shape="rectangle">
   <solid
      android:color="@color/orange"
   />
</shape>
```

The second is menu_selector.xml. It defines under which conditions the style in highlighted.xml will be displayed. This is an example of the use of State.

```
<?xml version="1.0" encoding="utf-8"?>
<selector xmlns:android="http://schemas.android.com/apk/res/android">
   <item android:state_pressed="true"
        android:drawable="@drawable/highlighted" /> <!-- pressed -->
   <item android:state_selected="true"
        android:drawable="@drawable/highlighted" /> <!-- selected -->
   <item android:state_focused="true"
        android:drawable="@drawable/highlighted" /> <!-- focused -->
   <item android:drawable="@drawable/back_gradient" /> <!-- default -->
</selector>
```

The conditions in menu_selector.xml will be automatically judged and result in related displays.

9. Create animation for the welcome screen. All files describing animation should be put in **/res/anim**. Create a file fade_in.xml. The source code is as follows:

```
<?xml version="1.0" encoding="utf-8"?>
<set
   xmlns:android="http://schemas.android.com/apk/res/android"
   android:shareInterpolator="false">
   <alpha
      android:fromAlpha="0.0"
      android:toAlpha="1.0"
      android:duration="5000">
   </alpha>
</set>
```

It defines the starting transparency, the end transparency, and the duration of fade in.

10. Create another animation rotate.xml. The source code is as follows.

```
<?xml version="1.0" encoding="utf-8" ?>
<set
   xmlns:android="http://schemas.android.com/apk/res/android"
   android:shareInterpolator="false">
   <rotate
      android:fromDegrees="0"
      android:toDegrees="360"
      android:pivotX="50%"
      android:pivotY="50%"
      android:duration="2500" />
   <alpha
      android:fromAlpha="0.0"
      android:toAlpha="1.0"
      android:duration="2500">
   </alpha>
   <scale
      android:pivotX="50%"
      android:pivotY="50%"
      android:fromXScale=".1"
      android:fromYScale=".1"
      android:toXScale="1.0"
      android:toYScale="1.0"
      android:duration="2500" />
    </set>
```

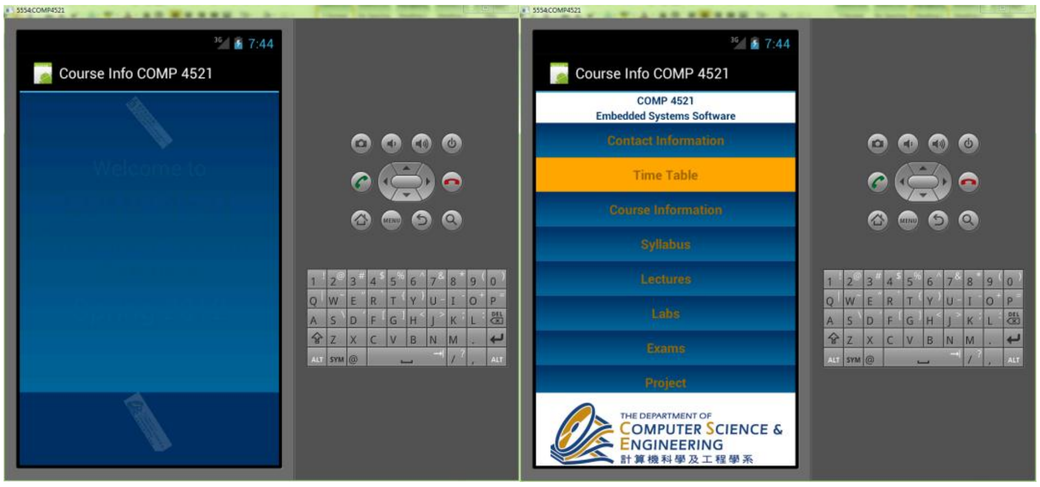
It defines the starting state and the end state of the rotated object. It also uses fade in and enlarge along with rotation.

11. Modify the source code of the welcome layout. It will apply animation and other visual styles to the welcome screen. We no longer need the onClick() method, because the layout will automatically jump to the menu layout and destroy itself. The source code of welcome.java is now as follows. Please read the comment to understand the source code.

```
public class welcome extends Activity {
     /** Called when the activity is first created. */
     @Override
     public void onCreate(Bundle savedInstanceState) {
          super.onCreate(savedInstanceState);
          setContentView(R.layout.welcome);

          // The welcome activity is now turned into a splash screen. The welcome screen
          // is splashed onto the screen, and then after 5 seconds, it automatically moves
          // to the menu activity

          // Animate the top and the bottom image using rotate.xml
          ImageView topimage = (ImageView) findViewById(R.id.WelcomeTopImage);
          ImageView bottomimage = (ImageView) findViewById(R.id.WelcomeBottomImage);
          Animation rotatein = AnimationUtils.loadAnimation(this, R.anim.rotate);
          topimage.startAnimation(rotatein);
          bottomimage.startAnimation(rotatein);

          // fade in the text on the splash screen
          Animation fadein = AnimationUtils.loadAnimation(this, R.anim.fade_in);

          LinearLayout innerlayout = (LinearLayout)
findViewById(R.id.WelcomeInnerLayout);

          // Apply the fade in animation to every child of the Inner Layout except the
          // imageview (child 0)
```

```
            for (int i = 1; i < innerlayout.getChildCount(); i++) {
                 TextView text = (TextView) innerlayout.getChildAt(i);
                 text.setAnimation(fadein);

                 // Declare an animation listener for the Fade in animation to complete. Once
                 // done, then invoke
                 // the animation listener and do the operations in the listener.
                 fadein.setAnimationListener(new Animation.AnimationListener() {

                      public void onAnimationEnd(Animation animation) {
                           // Create the Activity corresponding to the Menu screen
                           startActivity(new Intent(welcome.this,menu.class));
                           // Destroy the welcome screen activity
                           welcome.this.finish();
                      }

                      public void onAnimationRepeat(Animation animation) {
                           // TODO Auto-generated method stub

                      }

                      public void onAnimationStart(Animation animation) {
                           // TODO Auto-generated method stub

                      }
                 });
            }

       }
}
```

12. Run the application. Notice the animation of the welcome screen and the change of the menu buttons. Please try other styles as a practice.



Make Animation Using objectAnimator

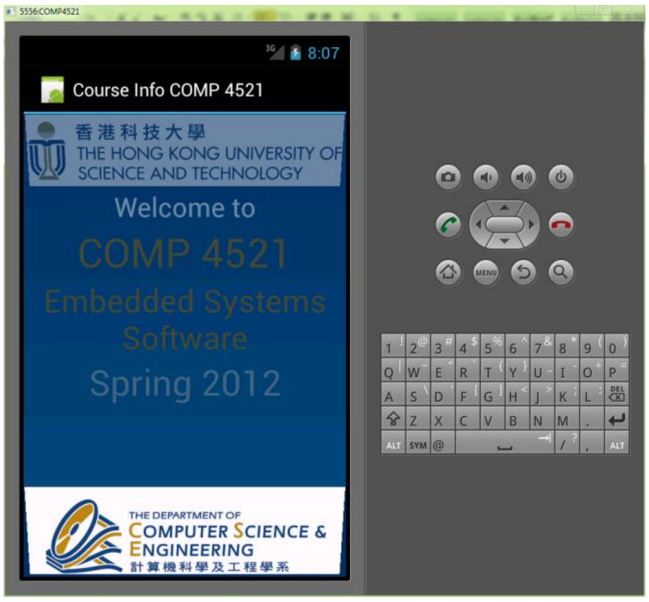
1. Now we use another approach, the objectAnimator to implement the animation we have done in the first part. First, we need to modify rotate.xml to define the objectAnimators. Notice the different effect of each objectAnimator.

```
<?xml version="1.0" encoding="utf-8"?>
<set xmlns:android="http://schemas.android.com/apk/res/android"
   android:ordering="sequentially" >

   <set>
      <objectAnimator
         android:duration="2500"
         android:pivotX="50%"
         android:pivotY="50%"
         android:propertyName="rotationX"
         android:valueFrom="0"
         android:valueTo="360"
         android:valueType="floatType" />
      <objectAnimator
         android:duration="2500"
         android:propertyName="alpha"
         android:valueFrom="0"
         android:valueTo="1"
         android:valueType="floatType" />
      <objectAnimator
         android:duration="2500"
         android:propertyName="scaleX"
         android:valueFrom="0.1"
         android:valueTo="1.0"
         android:valueType="floatType" />
      <objectAnimator
         android:duration="2500"
         android:propertyName="scaleY"
         android:valueFrom="0.1"
         android:valueTo="1.0"
         android:valueType="floatType" />
   </set>
</set>
```

2. Modify the source code of welcome.java. We make use of the objectAnimators in rotate.xml to define different animations for different components.

```
public class welcome extends Activity {
     /** Called when the activity is first created. */
     @Override
     public void onCreate(Bundle savedInstanceState) {
          super.onCreate(savedInstanceState);
          setContentView(R.layout.welcome);

          // The welcome activity is now turned into a splash screen. The welcome
          // screen is splashed
          // onto the screen, and then after 5 seconds, it automatically moves to
          // the menu activity

          // Animate the top and the bottom image using rotate.xml
          ImageView topimage = (ImageView) findViewById(R.id.WelcomeTopImage);
          ImageView bottomimage = (ImageView) findViewById(R.id.WelcomeBottomImage);
          AnimatorSet rotatein = (AnimatorSet) AnimatorInflater.loadAnimator(
                    this, R.anim.rotate);
          AnimatorSet rotatein2 = (AnimatorSet) AnimatorInflater.loadAnimator(
                    this, R.anim.rotate);
          rotatein.setTarget(topimage);
          rotatein2.setTarget(bottomimage);
          rotatein.start();
          rotatein2.start();

          // fade in the text on the splash screen
          LinearLayout innerlayout = (LinearLayout)
findViewById(R.id.WelcomeInnerLayout);
          ObjectAnimator textanim = (ObjectAnimator) ObjectAnimator.ofFloat(
                    innerlayout, "alpha", 0f, 1f);
          textanim.setDuration(5000);
          textanim.start();

          // Declare an animation listener for the textanim animation to complete.
          // Once done, then invoke
          // the animation listener and do the operations in the listener.
          textanim.addListener(new AnimatorListenerAdapter() {

               public void onAnimationEnd(Animator animation) {
                    // Create the Activity corresponding to the Menu screen
                    startActivity(new Intent(welcome.this, menu.class));
                    // Destroy the welcome screen activity
                    welcome.this.finish();
               }
          });
     }

  }
```

3. Run the application.


5556:COMP4521
8:07
Course Info COMP 4521
香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Welcome to
COMP 4521
Embedded Systems Software
Spring 2012
THE DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
計算機科學及工程學系

A Simple Ball Game

1. In this part we will create a simple ball game by extending the View class and using its onDraw() method. Unlike in the previous part, we are not using files describing animation or visual styles; all the visual effects are controlled by the source code.
2. Create a new project. The package name is hkust.comp4521.graphics, application name is Balls, and create an activity called Main.
3. Delete the default TextView in the main layout. Instead, we have a DrawView, which we will later define:

```
<hkust.comp4521.graphics.DrawView
   xmlns:android="http://schemas.android.com/apk/res/android"
   android:id="@+id/drawview"
     android:layout_width="fill_parent"
     android:layout_height="fill_parent" />
```

4. Modify the source code. We need 6 classes for our application. The first one is Main.java, which will only create a new activity. The content of main screen is defined in DrawView.java.

```
public class Main extends Activity {

     /** Called when the activity is first created. */
     @Override
     public void onCreate(Bundle savedInstanceState) {
          super.onCreate(savedInstanceState);
          requestWindowFeature(Window.FEATURE_NO_TITLE);
          setContentView(R.layout.main);

          // Load the View to draw on
          // Ths basically creates the screen using the DrawView class which is an
          // extension of the View class
          // setContentView(new DrawView(this));
          DrawView drawview = (DrawView) findViewById(R.id.drawview);

     }
    }
```

5. DrawView.java is responsible for creating the visual layout of the application. There are four main parts of the layout: the ball, the box in which the ball moves, the paddle which will reflect the ball when the ball hits it, and a message showing the score. The superclass of DrawView.java is android.view.View.

```
public class DrawView extends View {
        private Ball ball;
        private Box box;
        private Paddle paddle;
        private StatusMessage statusMsg;

    public DrawView(Context context, AttributeSet attrs) {
        super(context, attrs);

        setFocusable(true);
        this.requestFocus();
```

```
      // declare the bounding box, paddle, ball and status message
      box = new Box(0xff006699);  // ARGB
      paddle = new Paddle(Color.RED);
      ball = new Ball(Color.GREEN);
      statusMsg = new StatusMessage(Color.CYAN);

   }
   @Override protected void onDraw(Canvas canvas) {
      canvas.drawColor(Color.WHITE);    //if you want another background color

      // Draw the components
      box.draw(canvas);
      paddle.draw(canvas);
      ball.draw(canvas);
      statusMsg.draw(canvas);

      // Update the position of the ball, including collision detection and reaction.
      ball.moveBall(box, paddle);
      statusMsg.update(ball);

      // Delay for a short while before forcing another redraw of the screen
      try {
         Thread.sleep(30);
      } catch (InterruptedException e) { }

      // A call to invalidate causes the Android framework to call the onDraw method of
the DrawView
      // Thus every time the screen is refreshed, the framework is again forced to call
the onDraw
      // method. This creates the animation on the screen to simulate the game playing
      invalidate();
   }

   // Called back when the view is first created or its size changes.
   @Override
   public void onSizeChanged(int w, int h, int oldW, int oldH) {
      // Set the movement bounds for the ball
      box.set(0, 0, w, h);
      paddle.set(0, 0, w, h);
   }

   // Key-up event handler
   @Override
   public boolean onKeyUp(int keyCode, KeyEvent event) {
      switch (keyCode) {
         case KeyEvent.KEYCODE_DPAD_RIGHT: // Move paddle to the right
             paddle.moveright();
            break;
         case KeyEvent.KEYCODE_DPAD_LEFT:  // Move paddle to the left
             paddle.moveleft();
            break;
         case KeyEvent.KEYCODE_DPAD_UP:    // Increase ball speed
            ball.speedX++;
            ball.speedY++;
            break;
         case KeyEvent.KEYCODE_DPAD_DOWN:  // Decrease ball speed
            ball.speedX--;
            ball.speedY--;
            break;
         case KeyEvent.KEYCODE_DPAD_CENTER: // Stop the ball
            ball.speedX = 0;
            ball.speedY = 0;
            break;
      }
      return true;  // Event handled
   }
}
```

6. The 4 components in DrawView, the ball, the box, the paddle and the status message are defined respectively in 4 classes. First, Ball.java:

```
public class Ball {
     float radius = 5;      // Ball's radius
     float x = radius + 20;  // Ball's center (x,y)
     float y = radius + 40;
     float speedX = 5;       // Ball's speed (x,y)
     float speedY = 3;
     int score = 0;
     private RectF bounds;   // Needed for Canvas.drawOval
     private Paint paint;    // The paint style, color used for drawing

     // Constructor
     public Ball(int color) {
          bounds = new RectF();
          paint = new Paint();
          paint.setColor(color);
     }

     public void moveBall(Box box, Paddle paddle) {
          // Get new (x,y) position
          x += speedX;
          y += speedY;
          // Detect collision and react
          if (x + radius > box.xMax) {
               speedX = -speedX;
               x = box.xMax-radius;
          } else if (x - radius < box.xMin) {
               speedX = -speedX;
               x = box.xMin+radius;
          }
          if ((y + radius > paddle.yMin) && (x - radius > paddle.xMin) && (x + radius <
paddle.xMax)) {
               speedY = -speedY;
               y = paddle.yMin - radius;
               score++;
          } else if (y + radius > box.yMax){
               speedY = -speedY;
               y = box.yMin + radius;
               score--;
          }else if (y - radius < box.yMin) {
               speedY = -speedY;
               y = box.yMin + radius;
          }
     }

     public void draw(Canvas canvas) {
          bounds.set(x-radius, y-radius, x+radius, y+radius);
          canvas.drawOval(bounds, paint);
     }
}
```

7. Box.java:

```
// This class keeps track of the bounding box within which the ball must move
public class Box {
     int xMin, xMax, yMin, yMax;
     private Paint paint; // paint style and color
     private Rect bounds;

     public Box(int color) {
          paint = new Paint();
          paint.setColor(color);
          bounds = new Rect();
     }

     public void set(int x, int y, int width, int height) {
          xMin = x + 1;
          xMax = x + width - 1;
          yMin = y + 1;
          yMax = y + height - 1;
          // The box's bounds do not change unless the view's size changes
          bounds.set(xMin, yMin, xMax, yMax);
     }

     // Draw the box onto the canvas
     public void draw(Canvas canvas) {
          canvas.drawRect(bounds, paint);
     }
}
```

8. Paddle.java:

```
public class Paddle {
     int xMin, xMax, yMin, yMax;
     private Paint paint;  // paint style and color
     private Rect bounds;
     private int w;
     private int movesize;

     public Paddle(int color) {
          paint = new Paint();
          paint.setColor(color);
          bounds = new Rect();
          movesize = 20;
     }

     public void set(int x, int y, int width, int height) {
          // paddle size is set to one fifth of the screen width and initially centered
          // on the screen
          xMin = x+2*width/5;
          xMax = x + 3*width/5;
          yMin = y+height-10;
          yMax = y + height - 5;
          w = width;
          // The box's bounds do not change unless the view's size changes
          bounds.set(xMin, yMin, xMax, yMax);
     }

     public void moveright() {
          // move the paddle to the right
          if (xMax < w){
               xMin += movesize;
               xMax += movesize;
          }

          bounds.set(xMin, yMin, xMax, yMax);
     }

     public void moveleft() {
          // move the paddle to the left
          if (xMin > 0){
               xMin -= movesize;
               xMax -= movesize;
          }

          bounds.set(xMin, yMin, xMax, yMax);
     }

     // draw the paddle onto the canvas
     public void draw(Canvas canvas) {
          canvas.drawRect(bounds, paint);
     }
}
```

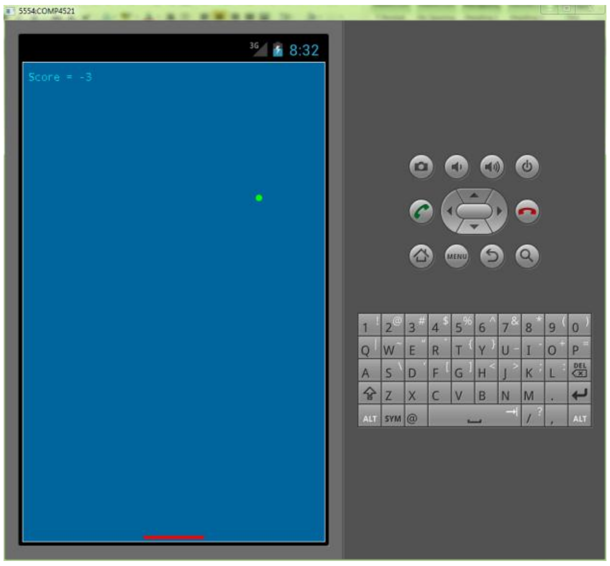
9. StatusMessage.java:

```
public class StatusMessage {
     // Status message to show the score.
     private StringBuilder statusMsg = new StringBuilder();
     private Formatter formatter = new Formatter(statusMsg);
     private Paint paint;

     // Constructor
     public StatusMessage(int color) {
          paint = new Paint();
          // Set the font face and size of drawing text
          paint.setTypeface(Typeface.MONOSPACE);
          paint.setTextSize(16);
          paint.setColor(color);
     }

     public void update(Ball ball) {
          // Build status message
          statusMsg.delete(0, statusMsg.length()); // Empty buffer
          formatter.format("Score = %d", ball.score);
     }

     public void draw(Canvas canvas) {
          canvas.drawText(statusMsg.toString(), 10, 30, paint);
     }
    }
```

10. To maintain the orientation of the screen, add a parameter in the AndroidManifest.xml.

```
android:screenOrientation="portrait"
```

11. Run the application. Click the 4 direction keys and enter to see what will happen, and go back to the source code to understand how the functions are implemented. Finally, enjoy the game and try your best to get a high score!



ANOTHER APPROACH: USING SURFACEVIEW

1. In this part we will use another approach to implement the ball game. The SurfaceView class provides a dedicated drawing surface embedded inside of a view hierarchy.
2. Modify the source code of DrawView.java. Now we use SurfaceView as its superclass. An extra thread is created to control the surface.

```java
public class DrawView extends SurfaceView implements SurfaceHolder.Callback {
     private DrawViewThread drawviewthread;
     private Ball ball;
     private Box box;
     private Paddle paddle;
     private StatusMessage statusMsg;

     public DrawView(Context context, AttributeSet attrs) {
          super(context, attrs);

          getHolder().addCallback(this);

          setFocusable(true);
          this.requestFocus();

          // declare the bounding box, paddle, ball and status message
          box = new Box(0xff006699);  // ARGB
          paddle = new Paddle(Color.RED);
          ball = new Ball(Color.GREEN);
          statusMsg = new StatusMessage(Color.CYAN);

     }

     public void drawGameBoard(Canvas canvas) {
          canvas.drawColor(Color.WHITE);     //if you want another background color

          // Draw the components
          box.draw(canvas);
          paddle.draw(canvas);
          ball.draw(canvas);
          statusMsg.draw(canvas);

          // Update the position of the ball, including collision detection and reaction.
          ball.moveBall(box, paddle);
          statusMsg.update(ball);

     }

     public void stopGame(){
          if (drawviewthread != null){
               drawviewthread.setRunning(false);
          }
     }

     public void releaseResources(){

     }

     // Called back when the view is first created or its size changes.
     @Override
     public void onSizeChanged(int w, int h, int oldW, int oldH) {
          // Set the movement bounds for the ball
          box.set(0, 0, w, h);
          paddle.set(0, 0, w, h);
     }
```

```
// Key-up event handler
@Override
public boolean onKeyUp(int keyCode, KeyEvent event) {
     switch (keyCode) {
     case KeyEvent.KEYCODE_DPAD_RIGHT: // Move paddle to the right
          paddle.moveright();
          break;
     case KeyEvent.KEYCODE_DPAD_LEFT:  // Move paddle to the left
          paddle.moveleft();
          break;
     case KeyEvent.KEYCODE_DPAD_UP:    // Increase ball speed
          ball.speedX++;
          ball.speedY++;
          break;
     case KeyEvent.KEYCODE_DPAD_DOWN:  // Decrease ball speed
          ball.speedX--;
          ball.speedY--;
          break;
     case KeyEvent.KEYCODE_DPAD_CENTER: // Stop the ball
          ball.speedX = 0;
          ball.speedY = 0;
          break;
     case KeyEvent.KEYCODE_BACK:
          stopGame();
     }
     return true;  // Event handled
}

public void surfaceChanged(SurfaceHolder holder, int format, int width,
          int height) {
     // TODO Auto-generated method stub

}

public void surfaceCreated(SurfaceHolder holder) {
     // TODO Auto-generated method stub
     drawviewthread = new DrawViewThread(holder);
     drawviewthread.setRunning(true);
     drawviewthread.start();

}

public void surfaceDestroyed(SurfaceHolder holder) {
     // TODO Auto-generated method stub
     boolean retry = true;
     drawviewthread.setRunning(false);

     while (retry){
          try {
               drawviewthread.join();
               retry = false;
          }
          catch (InterruptedException e){

          }
     }

}

public class DrawViewThread extends Thread{
     private SurfaceHolder surfaceHolder;
     private boolean threadIsRunning = true;

     public DrawViewThread(SurfaceHolder holder){
          surfaceHolder = holder;
          setName("DrawViewThread");
     }
```

```
            public void setRunning (boolean running){
                  threadIsRunning = running;
            }

            public void run() {
                  Canvas canvas = null;

                  while (threadIsRunning) {

                        try {
                              canvas = surfaceHolder.lockCanvas(null);

                              synchronized(surfaceHolder){
                                    drawGameBoard(canvas);
                              }
                              sleep(30);
                        } catch (InterruptedException e) {
                              // TODO Auto-generated catch block
                              e.printStackTrace();
                        }
                        finally {
                              if (canvas != null)
                                    surfaceHolder.unlockCanvasAndPost(canvas);
                        }
                  }
            }
      }
}
```

3. Update the Main.java. Two extra methods are added:

```
@Override
public void onPause(){
  super.onPause();
  drawview.stopGame();
}

@Override
public void onDestroy(){
  super.onDestroy();
  drawview.releaseResources();
}
```

4. Run the application. Since we use an extra thread to control the surface, the application is now more agile.