CSCI 1106
Lecture 15

Movement and Collision Detection

Announcements

- Today's Topics
  - A brief reminder of the Movie Metaphor
  - Autonomous object movement
  - Movement beyond the stage
  - Collision detection

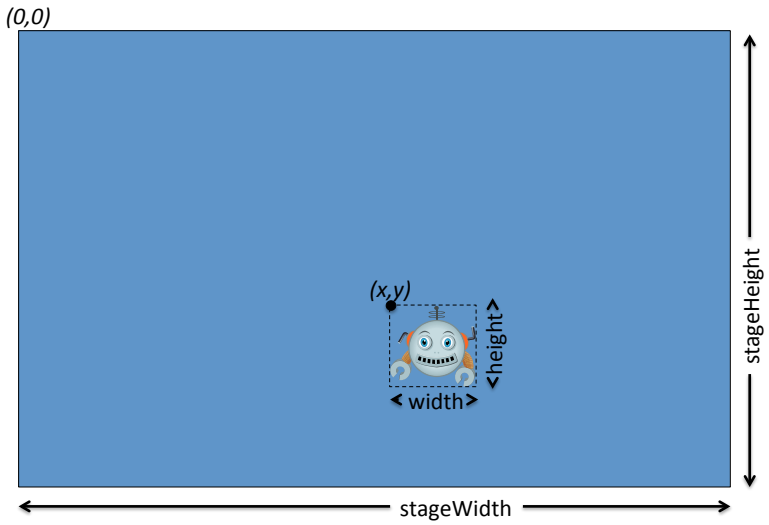
Reminders

- Drop deadline is March 8
- You need to pass the individual component (quizzes and final) to pass the course
- If your quiz average is less than 50%, please come and see me

The Movie Metaphor

- Key Idea: Stage is updated 60 times per second
  - ENTER_FRAME event
  - Redraw all objects on the stage
- Key Idea: On the ENTER_FRAME event
  - Update the positions and properties of all objects
  - Add/remove objects as needed
  - Update graphics as needed
- Idea: Change in an object's position from frame to frame looks like object motion

The Setup



Autonomous Motion

- Listen for the NEXT_FRAME event
- Set the object's velocity *(vx,vy)*
  - *vx* is how many pixels per frame the object moves horizontally
  - *vy is how many pixels per frame the object moves vertically*
  - *Either can be positive or negative*
- On each frame increment the *(x,y)* position of the object by its velocity
  - `object.x = object.x + object.vx;`
  - `object.y = object.y + object.vy;`

Issues with Motion

- Where should we set the object's velocity?
- What does it mean if the velocity is negative?
- What happens if the velocity is too great?
- Must the velocity be constant?
- What happens if we hit the wall?

Hitting the Wall

- Fact: If the object keeps moving it will reach the edge of the stage
- Two options:
  - Fall off the edge
  - Bounce back
- How do we know when we have hit the wall?
- Does it matter which wall it is?

Falling of the Edge

- Idea: Once object is no longer visible, remove it
- How do we know when an object is no longer visible?
  - Bottom edge of object is at the top wall:
    `object.y < -object.height`
  - Top edge of object is at the bottom wall:
    `object.y > stage.stageHeight`
  - Right edge of object is at the left wall:
    `object.x < -object.width`
  - Left edge of object is at the right wall:
    `object.x > stage.stageHeight`
- Where do we perform the test?
- If the test is positive: remove the object

Bouncing of the Wall

- Idea: Once object touches a wall, reverse velocity
- How do we know which velocity to reverse (*vx* or *vy*)?
- Reverse *vy* if
  - Top edge of object is at the top wall
    `object.y <= 0`
  - Bottom edge of object is at the bottom wall
    `object.y + object.height >= stage.stageHeight`
- Reverse *vx* if
  - left edge of object is at the left wall:
    `object.x <= 0`
  - Right edge of object is at the right wall:
    `object.x + object.width >= stage.stageWidth`
- How do we reverse velocity?
- Where do we perform the test?

Collision Detection

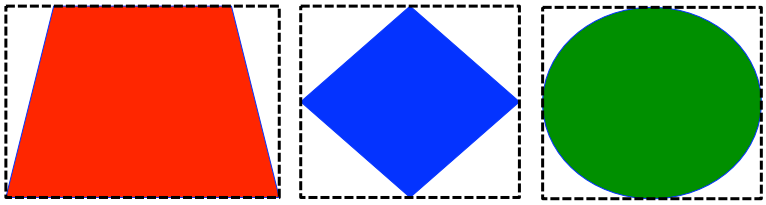
- Obs: Previous slides described a special form of *collision detection*
- In general, *collision detection* is needed to detect if two or more objects are intersecting or touching in some way
- Why is this useful?

Mechanisms for Collision Detection

- Three ways to detect collisions:
  - Cheap and fast: Check if bounding boxes overlap
    - Use `hitTestObject()`
  - Expensive and slow: Check if the points of one object intersect with the other
    - Use `hitTestPoint()`
  - More complicated and fast: Use invisible objects
- For most purposes, the first way suffices

Bounding Boxes

- Defn: A *bounding box* of an object is the smallest orthogonal rectangle that can contain the object

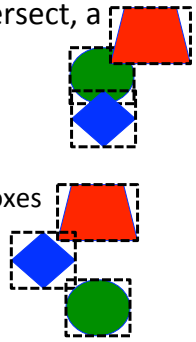


hitTestObject()

- Idea: If the bounding boxes of two objects intersect, a collision has occurred
- Pros: Fast, cheap, simple to use
- Cons:
  - Cannot determine where the collision occurred
  - Irregularly shaped objects have large bounding boxes
  - False positives
- Use:

```
if(objA.hitTestObject(objB))
{ …
}
```

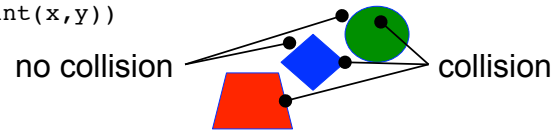
- Obs: Need finer granularity mechanism



hitTestPoint()

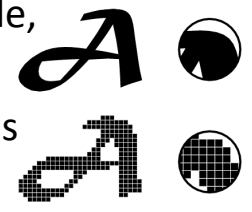
- Ideas:
  - Detect whether a specific point is within the shape of the object
  - Useful on vector objects (ones you draw with the rectangle tool)
  - Only the drawn part is checked for overlap with the point
  - The bounding box isn't considered!
- Pros: Still pretty simple
- Cons:
  - Can only check one point
  - Objects comprise many points so object collisions require multiple checks
    - E.g. ball and paddle
    - Expensive and slow if many points need to be checked
  - Does not work for bitmapped graphics
- Use:

```
if(obj.hitTestPoint(x,y))
{ …
}
```

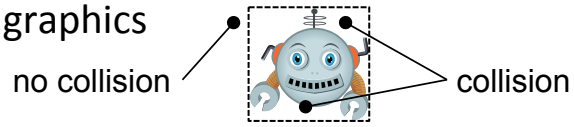


Vector vs Bitmapped Graphics

- Vector based graphics are those that you draw using the rectangle, circle, or other tools
- Bitmap based graphics are pictures that you import
- Problem: Flash uses the bounding box for point hit detection on bitmapped graphics

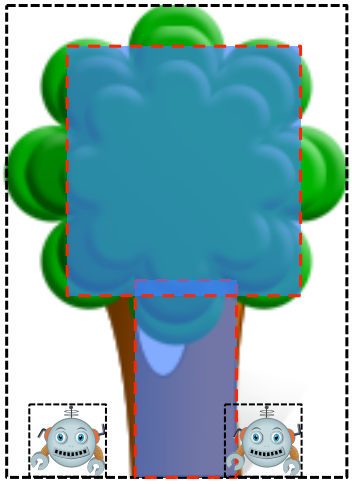


http://www.snap.ednet.ns.ca/hhs/tprofittcmt12/images/vector-vs-bitmap.png



A Compound Approach

- Problem:
  - Need to use `hitTestObject()` on irregular shaped object
  - Bounding box of object differs from object shape
- Solution:
  - Create invisible objects within this object with smaller bounding boxes
  - Use the smaller bounding boxes to detect collisions



no collision collision