CS193P - Lecture 15

iPhone Application Development

iPhone Device APIs
Location, Accelerometer & Camera

Battery Life & Power Management

Announcements

- Paparazzi 4 due ***Friday*** night at 11:59PM
  - Late days: use 'em if you've got 'em
- Work on final projects!

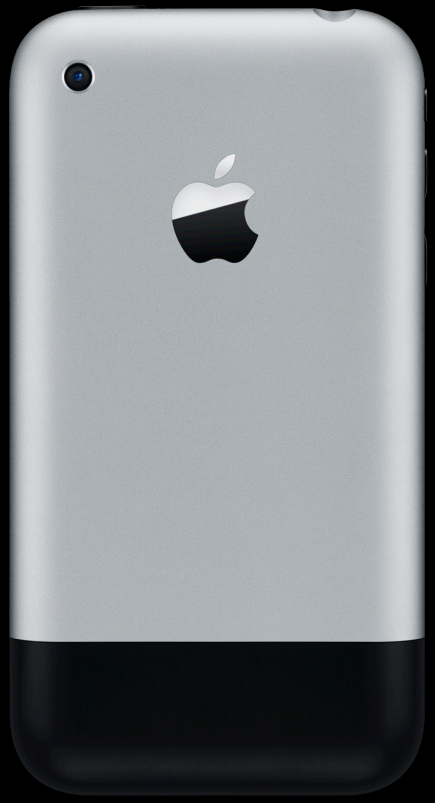
Today's Topics

- Hardware features
  - Image Picker & Camera
  - Location
  - Accelerometer
- Battery Life & Power Management

Lots of Cool Features

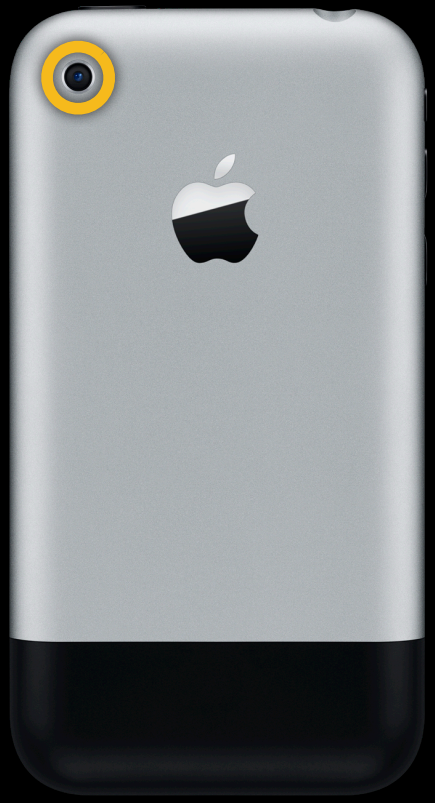
Device Hardware

Camera



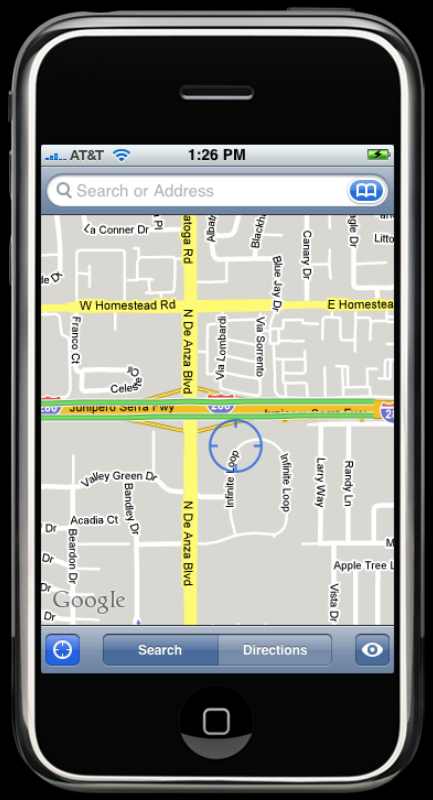
Device Hardware

Camera



Device Hardware

Core location



Device Hardware

Accelerometers

Limited Simulator Support

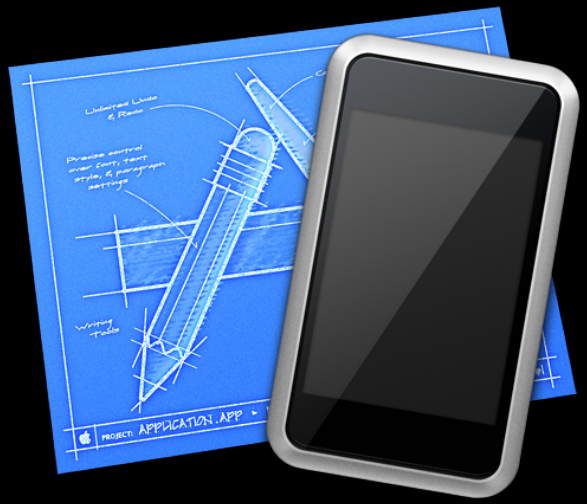


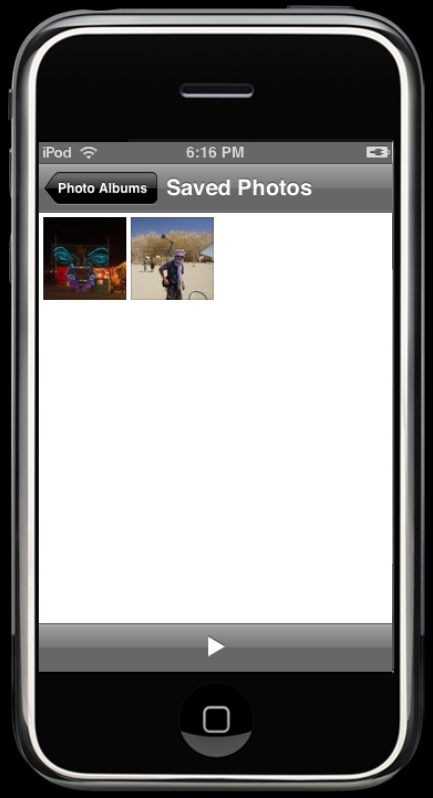
Image Picker

The Image Picker Interface

The camera

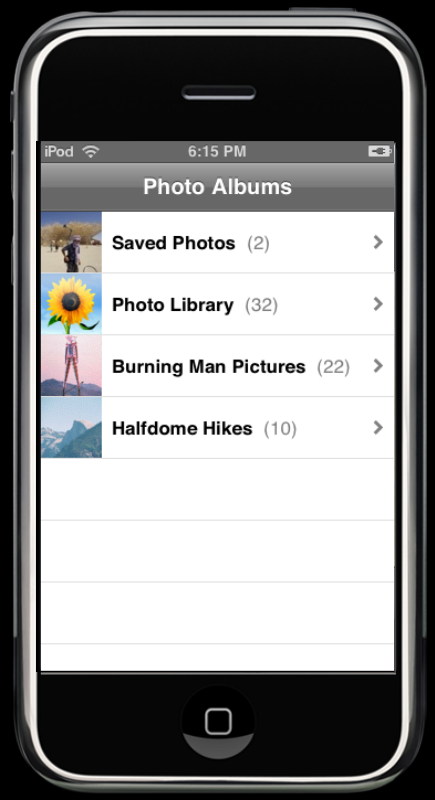
The Image Picker Interface

Saved photos



The Image Picker Interface

The photo library



The Image Picker Interface

Displaying the interface

- UIImagePickerController class
  - Use as-is (no subclassing)
  - Handles all user and device interactions
  - UIViewController Subclass
- UIImagePickerControllerDelegate protocol
  - Implemented by your delegate object

Displaying the Image Picker

Steps for using

- Check the source availability
- Assign a delegate object
- Present the controller modally

Displaying the Image Picker

Called from a view controller object

```
if ([UIImagePickerController isSourceTypeAvailable:
            UIImagePickerControllerSourceTypeCamera])
{
    UIImagePickerController* picker =
            [[UIImagePickerController alloc] init];
    picker.sourceType = UIImagePickerControllerSourceTypeCamera;
    picker.delegate = self;

    [self presentModalViewController:picker animated:YES];
}
```

Displaying the Image Picker

Called from a view controller object

```
if ([UIImagePickerController isSourceTypeAvailable:
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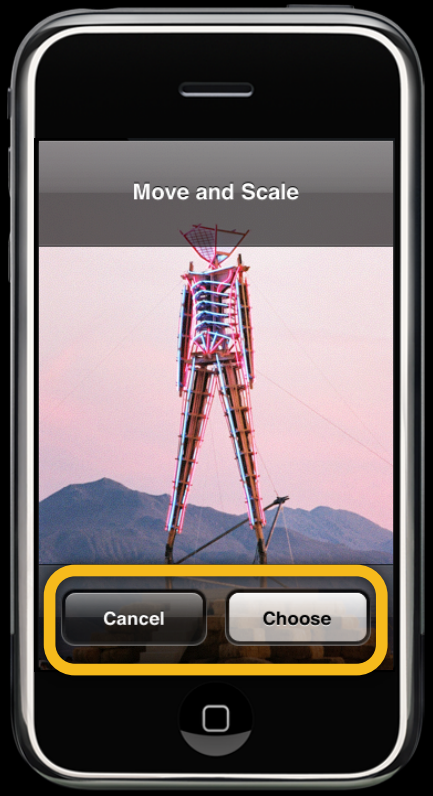
    [self presentModalViewController:picker animated:YES];
}
```

Selecting an Image

Selecting an Image



Defining Your Delegate Object

The UIImagePickerControllerDelegate protocol

- Two methods:

```
- (void)imagePickerController:(UIImagePickerController*)picker
      didFinishPickingImage:(UIImage*)image
                editingInfo:(NSDictionary*)editingInfo;
```

```
- (void)imagePickerControllerDidCancel:
                (UIImagePickerController*)picker;
```

Defining Your Delegate Object

The accept case

```
- (void)imagePickerController:(UIImagePickerController*)picker
        didFinishPickingImage:(UIImage*)image
                  editingInfo:(NSDictionary*)editingInfo
{
    // Save or use the image here.

    // Dismiss the image picker.
    [self dismissModalViewControllerAnimated:YES];
    [picker release];
}
```

Defining Your Delegate Object

The accept case

```
- (void)imagePickerController:(UIImagePickerController*)picker
        didFinishPickingImage:(UIImage*)image
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Defining Your Delegate Object

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    [picker release];
}
```

Defining Your Delegate Object

The cancel case

```
- (void)imagePickerControllerDidCancel:
                (UIImagePickerController*)picker
{
    // Dismiss the image picker.
    [self dismissModalViewControllerAnimated:YES];
    [picker release];
}
```

Defining Your Delegate Object

The cancel case

```
- (void)imagePickerControllerDidCancel:
                (UIImagePickerController*)picker
{
    // Dismiss the image picker.
    [self dismissModalViewControllerAnimated:YES];
    [picker release];
}
```

Defining Your Delegate Object

The cancel case

```
- (void)imagePickerControllerDidCancel:
                (UIImagePickerController*)picker
{
    // Dismiss the image picker.
    [self dismissModalViewControllerAnimated:YES];
    [picker release];
}
```

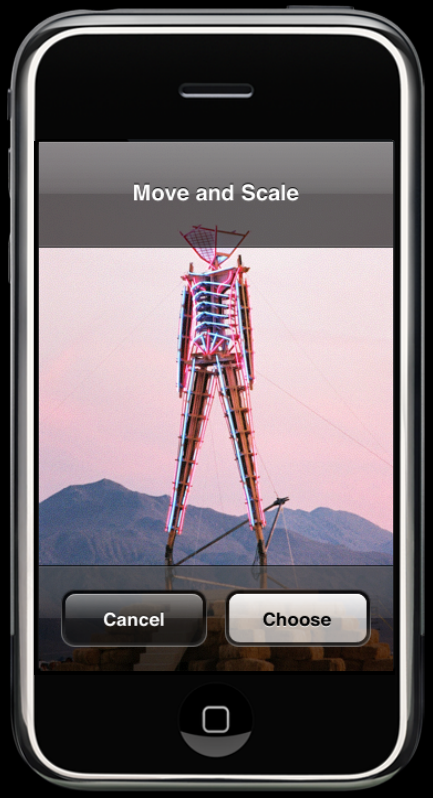
Manipulating the Returned Image

Allowing users to edit returned images

- If allowsImageEditing property is YES:
  - User allowed to crop the returned image
  - Image metadata returned in editingInfo

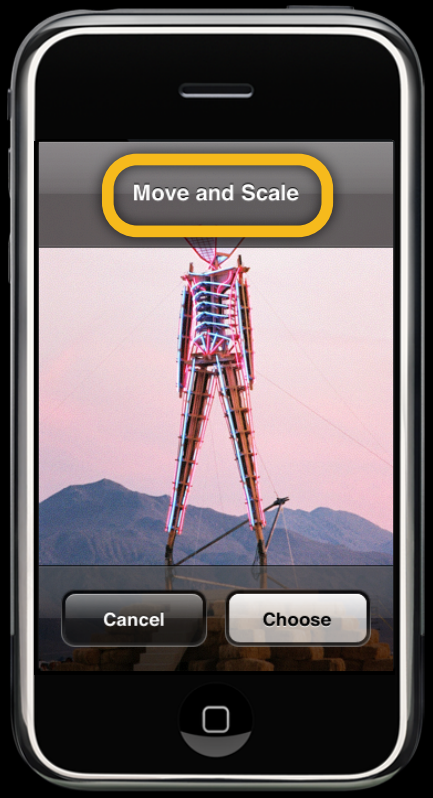
Manipulating the Returned Image

Allowing users to edit returned images



Manipulating the Returned Image

Allowing users to edit returned images



Manipulating the Returned Image

The editingInfo dictionary

```
- (void)imagePickerController:(UIImagePickerController*)picker
        didFinishPickingImage:(UIImage*)image
                  editingInfo:(NSDictionary*)editingInfo
{
    // Save or use the image here.

    // Dismiss the image picker.
    [self dismissModalViewControllerAnimated:YES];
    [picker release];
}
```

Manipulating the Returned Image

The editingInfo dictionary

- Original image in UIImagePickerControllerOriginalImage key
- Crop rectangle in UIImagePickerControllerCropRect key

Augmented Reality

Walk around looking through a camera.
What could possibly go wrong?

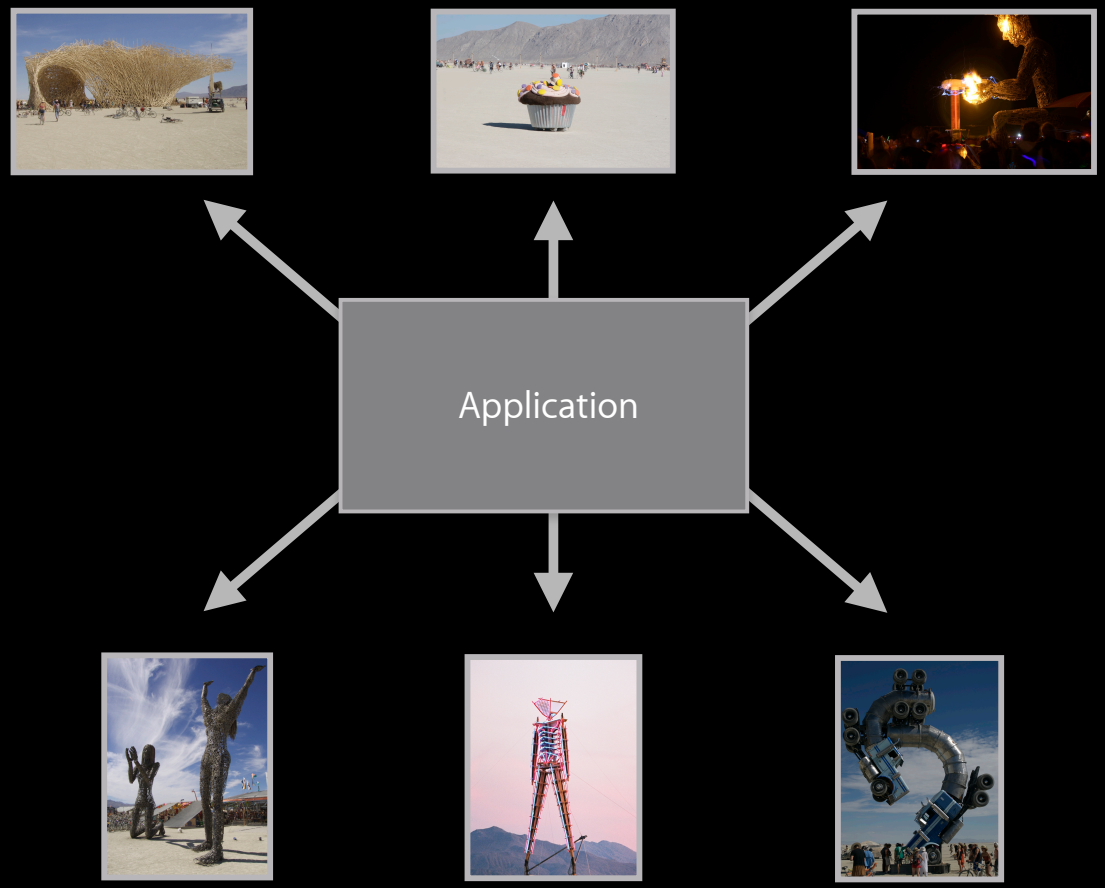
```
@property          BOOL                 showsCameraControls;
@property(retain)  UIView               cameraOverlayView;
@property          CGAffineTransform    cameraViewTransform;
```

The Image Picker Interface

Custom Camera Interface

Managing Image Data

Avoid retaining images



Saving Images

Writing to the saved photos album

- UIImageWriteToSavedPhotosAlbum function
  - Photos can be downloaded to iPhoto by user
  - Optional completion callback

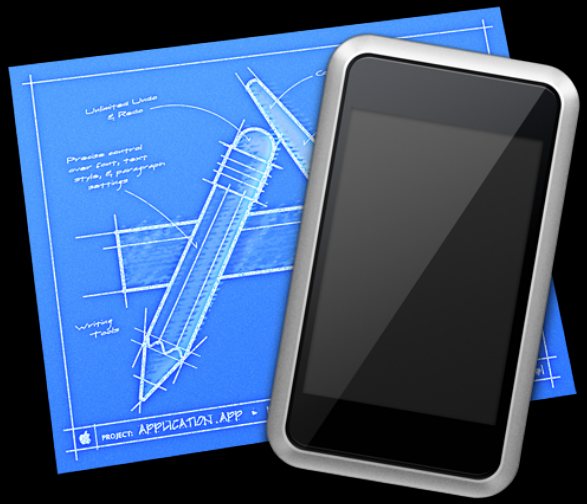
Saving Videos

Writing to the saved photos album

- UIVideoAtPathIsCompatibleWithSavedPhotosAlbum

- UISaveVideoAtPathToSavedPhotosAlbum function
  - Videos can be downloaded to iPhoto by user
  - Optional completion callback

Available in the Simulator



Key Tips

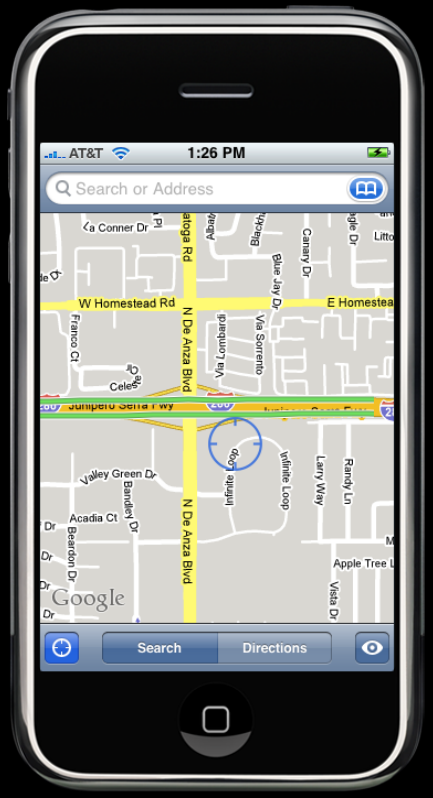
Using UIImagePickerController effectively

- Always check the source availability
- Your delegate methods do the cleanup
- Be frugal with images
- Available in the simulator

Core Location

Core Location

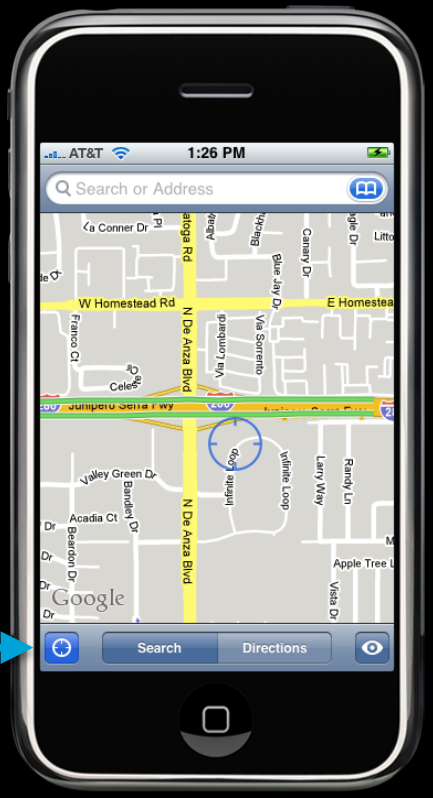
What is it?



Core Location

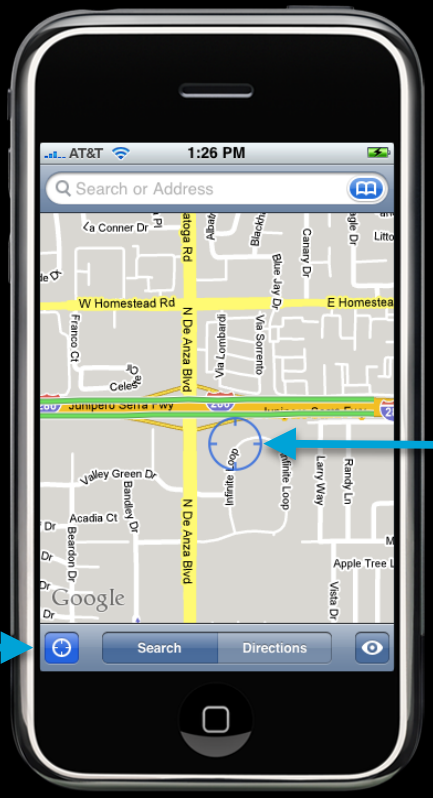
What is it?

Activate service



Core Location

What is it?



Location ring

Activate service

Core Location

How?

Core Location

How?

Core Location

How?

Core Location

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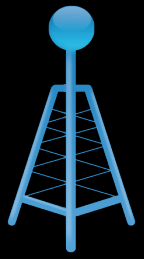
How?

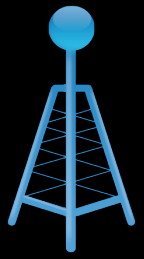
Core Location

Location Technologies



Core Location

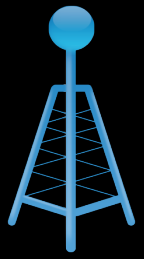
Location Technologies



Bootstrap

Core Location

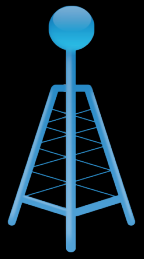
Location Technologies



Cross-check

Core Location

Location Technologies



Complement

Core Location Framework

Core Location Framework

The core classes and protocols

- Classes
  - CLLocationManager
  - CLLocation
- Protocol
  - CLLocationManagerDelegate

Core Location Framework

CLLocationManagerDelegate protocol

- Two optional methods

```
- (void)locationManager:(CLLocationManager*)manager
       didUpdateToLocation:(CLLocation*)newLocation
              fromLocation:(CLLocation*)oldLocation;
```

```
- (void)locationManager:(CLLocationManager*)manager
          didFailWithError:(NSError*)error;
```

- Called asynchronously on main thread
- Issues movement-based updates

Core Location Framework

CLLocationManagerDelegate protocol

- Two optional methods

```
- (void)locationManager:(CLLocationManager*)manager
       didUpdateToLocation:(CLLocation*)newLocation
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         didFailWithError:(NSError*)error;
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- Called asynchronously on main thread
- Issues movement-based updates

Getting a Location

Starting the location service

```
CLLocationManager* locManager =
                   [[CLLocationManager alloc] init];

locManager.delegate = self;
[locManager startUpdatingLocation];
```

Getting a Location

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Starting the location service

```
CLLocationManager* locManager =
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locManager.delegate = self;
[locManager startUpdatingLocation];
```

Getting a Location

Using the event data

```
- (void)locationManager:(CLLocationManager*)manager
       didUpdateToLocation:(CLLocation*)newLocation
              fromLocation:(CLLocation*)oldLocation
{




   // Use the coordinate data.
   double lat = newLocation.coordinate.latitude;
   double lon = newLocation.coordinate.longitude;
}
```

Getting a Location

Using the event data

```
- (void)locationManager:(CLLocationManager*)manager
       didUpdateToLocation:(CLLocation*)newLocation
              fromLocation:(CLLocation*)oldLocation
{
    NSTimeInterval howRecent =
            [newLocation.timestamp timeIntervalSinceNow];
    if (howRecent < -10) return;



   // Use the coordinate data.
   double lat = newLocation.coordinate.latitude;
   double lon = newLocation.coordinate.longitude;
}
```

Getting a Location

Using the event data

```
- (void)locationManager:(CLLocationManager*)manager
       didUpdateToLocation:(CLLocation*)newLocation
              fromLocation:(CLLocation*)oldLocation
{
    NSTimeInterval howRecent =
             [newLocation.timestamp timeIntervalSinceNow];
    if (howRecent < -10) return;

    if (newLocation.horizontalAccuracy > 100) return;

   // Use the coordinate data.
   double lat = newLocation.coordinate.latitude;
   double lon = newLocation.coordinate.longitude;
}
```

Getting a Heading

Using the event data

```
- (void)locationManager:(CLLocationManager *)manager
      didUpdateHeading:(CLHeading *)newHeading
{
   // Use the coordinate data.
   CLLocationDirection heading = newHeading.trueHeading;
}
```

Power Play (beat Canada again): CLLocationManager Properties

Desired Accuracy

Choosing an appropriate accuracy level

```
CLLocationManager* locManager =
                   [[CLLocationManager alloc] init];

locManager.desiredAccuracy = kCLLocationAccuracyBest;
```

- Choose an appropriate accuracy level
  - Higher accuracy impacts power consumption
  - Lower accuracy is "good enough" in most cases
- Can change accuracy setting later if needed
- Actual accuracy reported in CLLocation object

Distance Filter

Choosing an appropriate update threshold

```
CLLocationManager* locManager =
                   [[CLLocationManager alloc] init];

locManager.distanceFilter = 3000;
```

- New events delivered when threshold exceeded

Stopping the Service

```
CLLocationManager* locManager =
                   [[CLLocationManager alloc] init];
[locManager startUpdatingLocation];

...

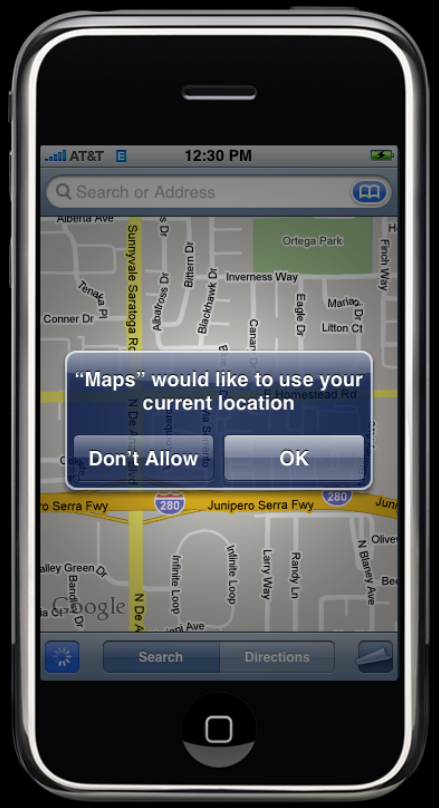
[locManager stopUpdatingLocation];
```

- Restart the service later as needed

Responding to Errors

User may deny use of the location service

- Results in a `kCLErrorDenied` error
- Protects user privacy
- Occurs on a per-application basis

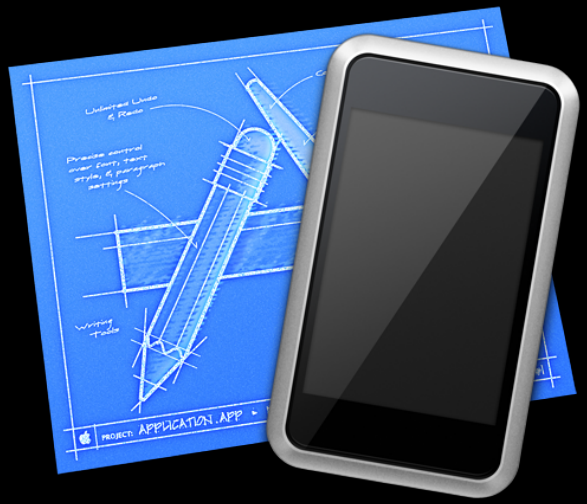


Responding to Errors

Location may be unavailable

- Results in a `kCLErrorLocationUnknown` error
- Likely just temporary
- Scan continues in background

Limited Simulator Support



Accelerometers

What Are Accelerometers?

Measure changes in force

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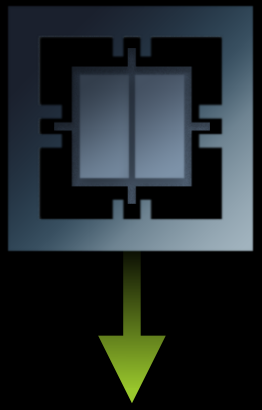
Measure changes in force



What Are Accelerometers?

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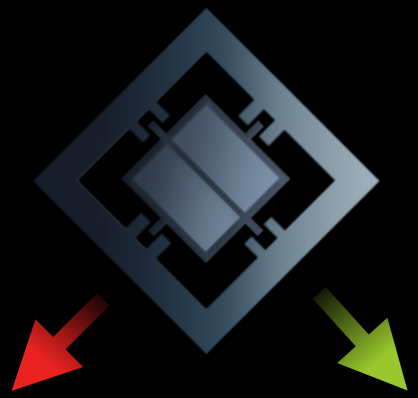


Accelerometers

What are the uses?

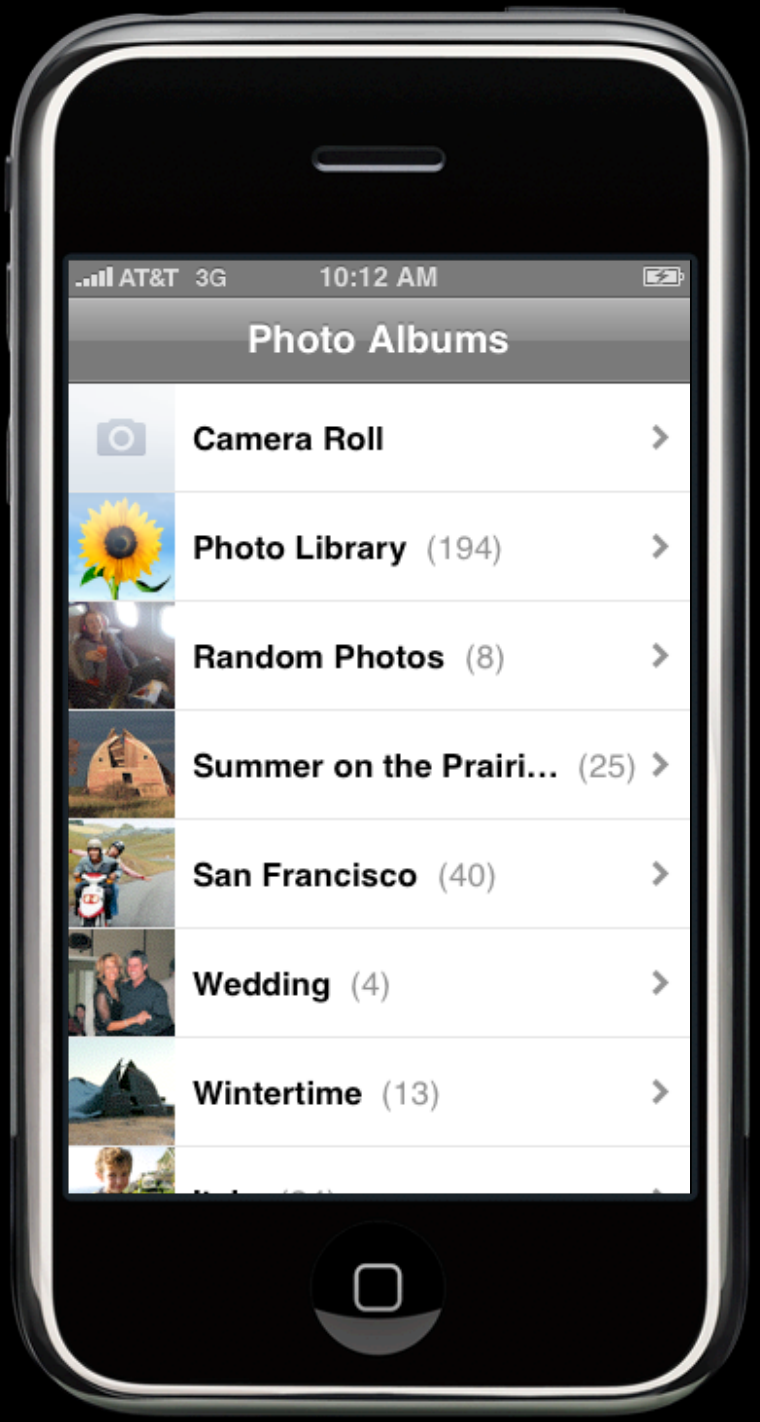
Accelerometers

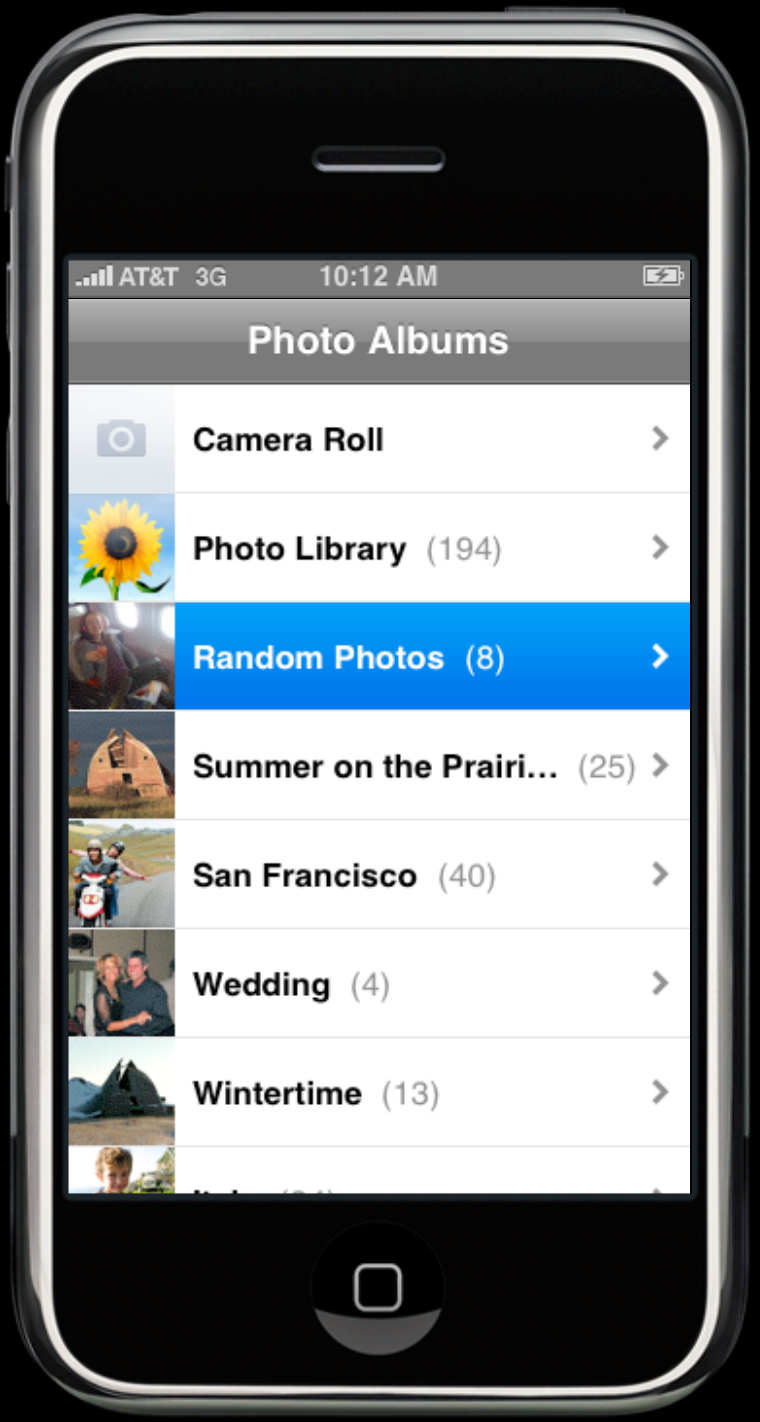
What are the uses?

Kinds of Orientation

The physical vs the interface

- Physical Orientation
  - How is the device positioned?
- Interface Orientation
  - Where is the status bar?
- Examples: Photos & Safari


AT&T 3G
10:12 AM
Photo Albums
Camera Roll
Photo Library (194)
Random Photos (8)
Summer on the Prairi... (25)
San Francisco (40)
Wedding (4)
Wintertime (13)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AT&T 3G
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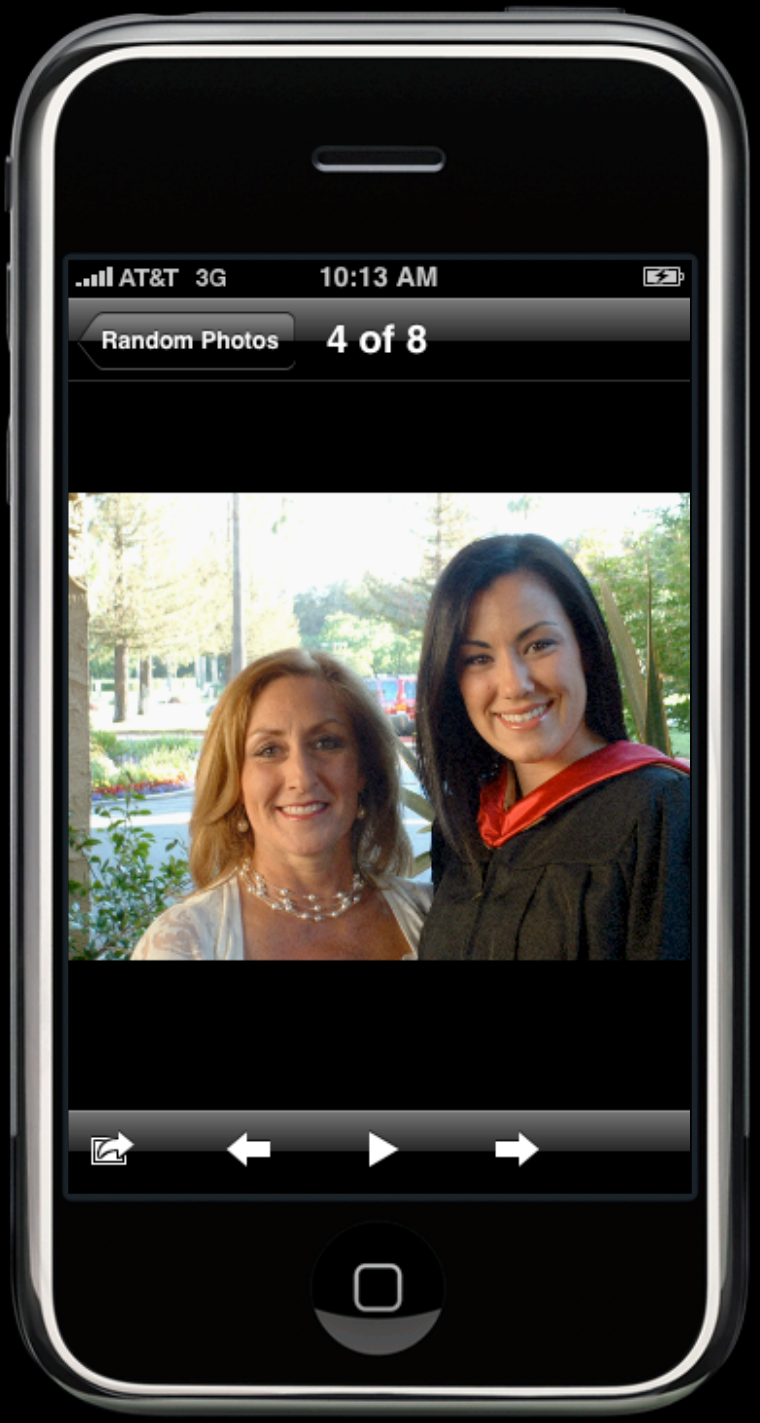
AT&T 3G
10:13 AM
Random Photos
4 of 8


AT&T 3G
10:13 AM
4 of 8
Random Photos


AT&T 3G
10:13 AM
Apple - iPhone
www.apple.com/iphone/
Google
iPhone 3G
35,000 apps. And counting.


AT&T 3G
10:13 AM
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AT&T 3G
10:13 AM
Apple - iPhone
www.apple.com/iphone/
Google
Store
Mac
iPod + iTunes
iPhone
Downloads
Support
Features
App Store
iTunes
Gallery
Tech Specs
Buy iPhone 3G
What's New in iPhone 3G
3G Speed
3G
iPhone in Enterprise
Exchange
Maps with GPS
Top Paid Apps
Top Free Apps
Staff Picks
NYTimes
Recorder
FlightTrack

Orientation-Related Changes

Getting the physical orientation

- UIDevice class
  - Start notifications
    - `beginGeneratingDeviceOrientationNotifications`
  - Get Orientation
    - `UIDeviceOrientationDidChangeNotification` delivered to registered observers
    - `orientation` property
  - Stop notifications
    - `endGeneratingDeviceOrientationNotifications`

Orientation-Related Changes

Getting the interface orientation

- UIApplication class
  - `statusBarOrientation` property
  - Defines interface orientation, not device orientation

- UIViewController class
  - `interfaceOrientation` property

```
- (BOOL)shouldAutorotateToInterfaceOrientation:
                    (UIInterfaceOrientation)interfaceOrientation
```

Shake

Undo!

- UIEvent type
  - `@property(readonly) UIEventType    type;`
  - `@property(readonly) UIEventSubtype subtype;`

  - `UIEventTypeMotion`
  - `UIEventSubtypeMotionShake`

Orientation changes are nice, but…

Wii™ Want Raw Data

0.75g

1.0g

0.5g

Wii™ Want Raw Data

0.75g

1.0g

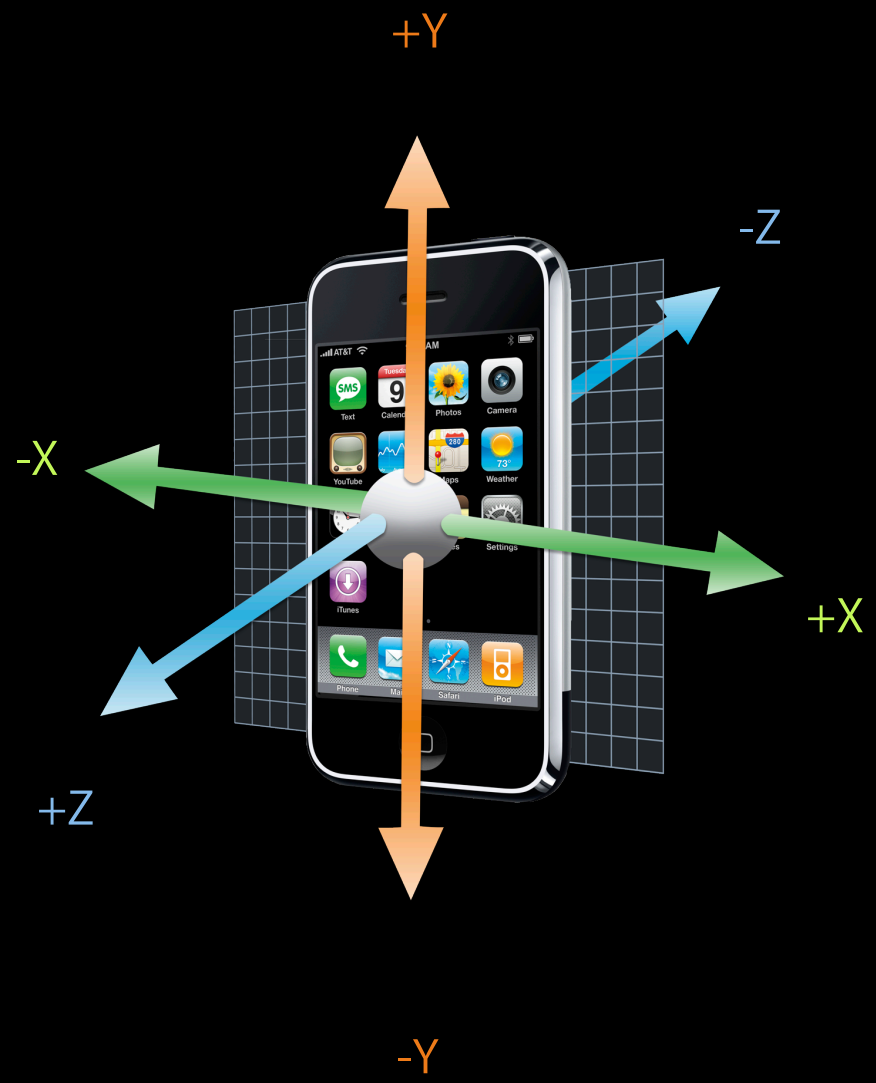
0.5g

The Accelerometer Interface

Getting the raw accelerometer data

- Part of the UIKit framework
- Delivers 3-axis data
- Configurable update frequency (approx 10–100Hz)
- Delegate-based event delivery

Device Axis Orientation



The Accelerometer Interface

Getting the raw accelerometer data

- Classes
  - UIAccelerometer
  - UIAcceleration
- Protocol
  - UIAccelerometerDelegate

Configuring the Accelerometer

Starting the event delivery

```
- (void)enableAccelerometerEvents
{
    UIAccelerometer* theAccel =
                        [UIAccelerometer sharedAccelerometer];
    theAccel.updateInterval = 1/50;  // 50 Hz
    theAccel.delegate = self;
}
```

Configuring the Accelerometer

Starting the event delivery

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    theAccel.updateInterval = 1/50;  // 50 Hz
    theAccel.delegate = self;
}
```

Event delivery begins as soon as you assign the delegate

Defining Your Delegate Object

Processing the accelerometer data

```
- (void)accelerometer:(UIAccelerometer*)accelerometer
        didAccelerate:(UIAcceleration*)acceleration
{
    // Get the event data
    UIAccelerationValue  x, y, z;

    x = acceleration.x;
    y = acceleration.y;
    z = acceleration.z;

    // Process the data...
}
```

Defining Your Delegate Object

Processing the accelerometer data

```
- (void)accelerometer:(UIAccelerometer*)accelerometer
        didAccelerate:(UIAcceleration*)acceleration
{
    // Get the event data
    UIAccelerationValue  x, y, z;

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    // Process the data...
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```

Defining Your Delegate Object

Processing the accelerometer data

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- (void)accelerometer:(UIAccelerometer*)accelerometer
          didAccelerate:(UIAcceleration*)acceleration
{
    // Get the event data
    UIAccelerationValue  x, y, z;

    x = acceleration.x;
    y = acceleration.y;
    z = acceleration.z;

    // Process the data...
}
```

- Only one delegate per application
- Delivered asynchronously to main thread

Configuring the Accelerometer

Choosing an appropriate update frequency

- System range is approximately 10–100Hz
- Frequency should be based on need
  - Determine the minimum frequency for your needs
  - Don't update too frequently
- Target ranges
  - Game input: 30–60 Hz
  - Orientation detection: 10–20 Hz

Disabling Event Delivery

Stopping the event delivery

```
- (void)disableAccelerometerEvents
{
    UIAccelerometer* theAccel =
                        [UIAccelerometer sharedAccelerometer];

    theAccel.delegate = nil;
}
```

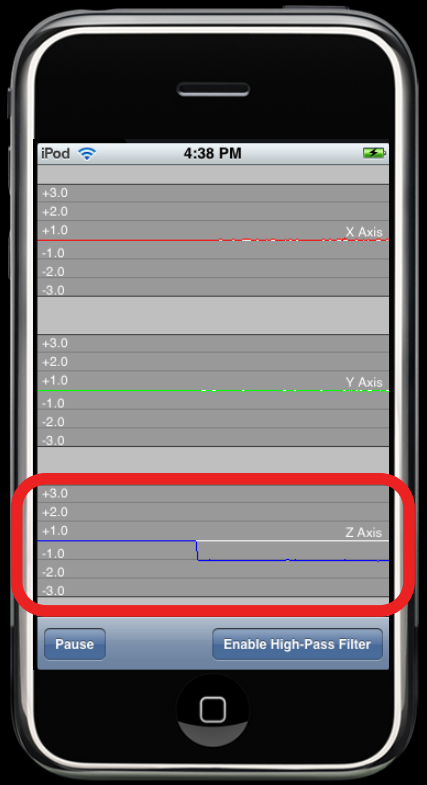
Filtering Accelerometer Data

Use filters to isolate data components

- Low-pass filter
  - Isolates constant acceleration
  - Used to find the device orientation
- High-pass filter
  - Shows instantaneous movement only
  - Used to identify user-initiated movement

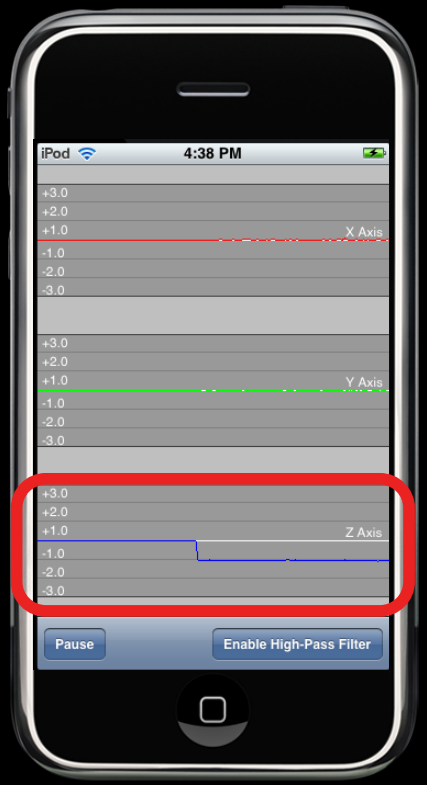
Filtering Accelerometer Data

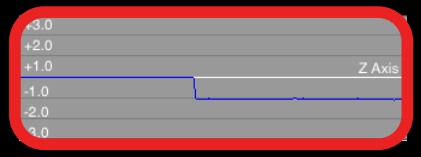
Examining the accelerometer data



Filtering Accelerometer Data

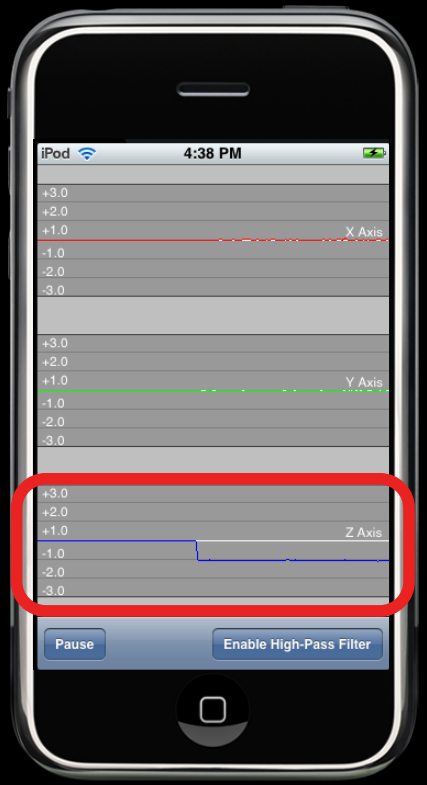
Examining the accelerometer data

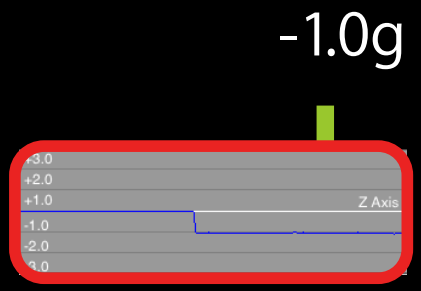




Filtering Accelerometer Data

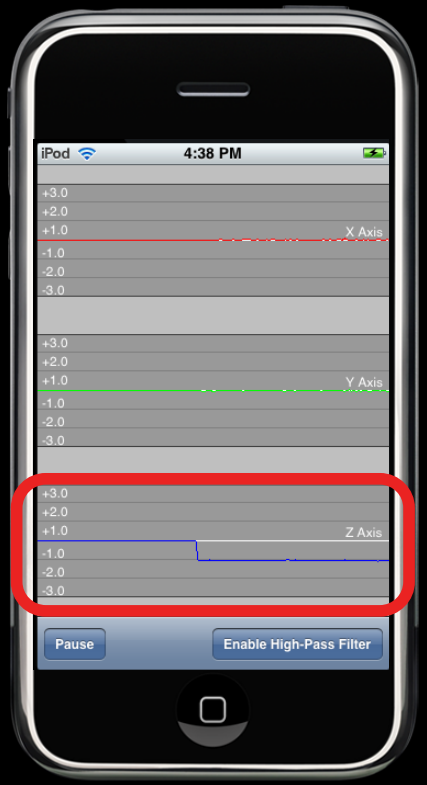
Examining the accelerometer data



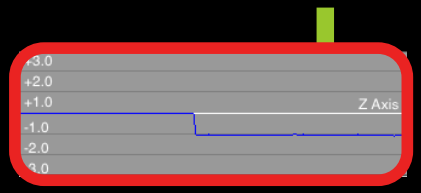


Filtering Accelerometer Data

Examining the accelerometer data



-1.0g



f(t)

Filtering Accelerometer Data

But, to apply a filter…

Filtering Accelerometer Data

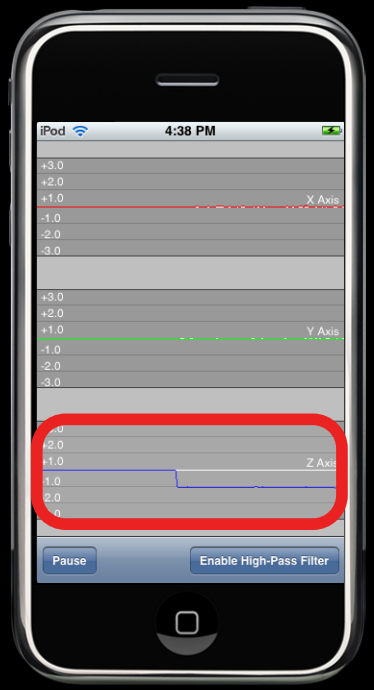
But, to apply a filter…

$$f(t) \Rightarrow F(\omega)$$

Fourier Transform

Filtering Accelerometer Data

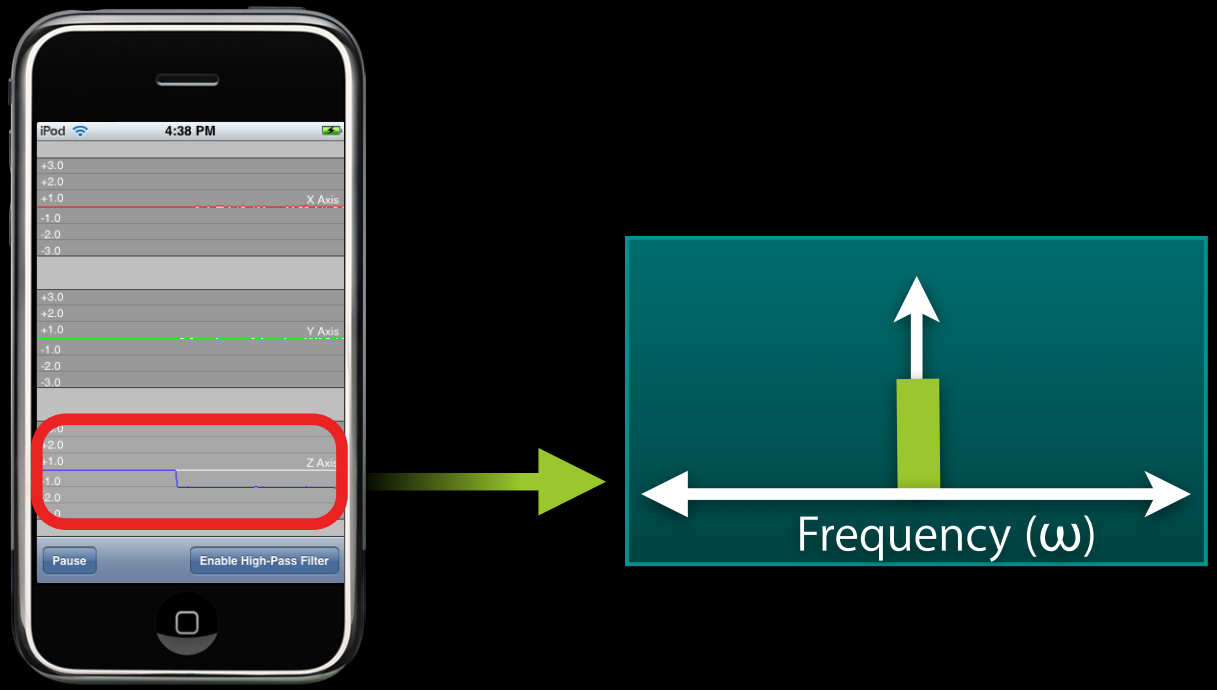
Changing to the frequency domain



f(t)

Filtering Accelerometer Data

Changing to the frequency domain

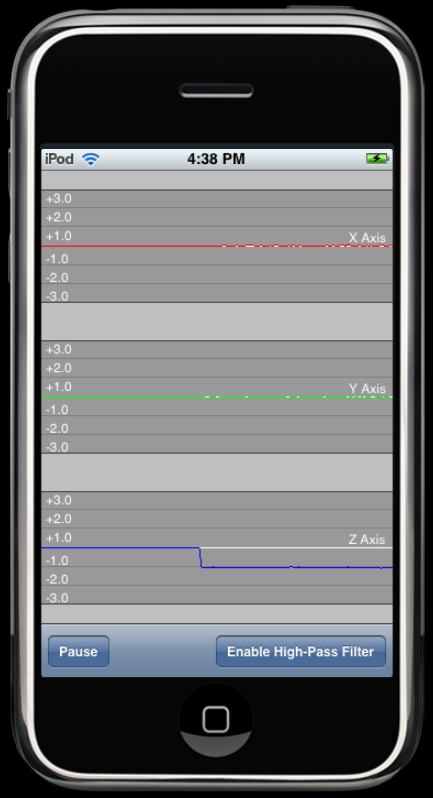


f(t)

F(ω)

Filtering Accelerometer Data

But if we shake the device…



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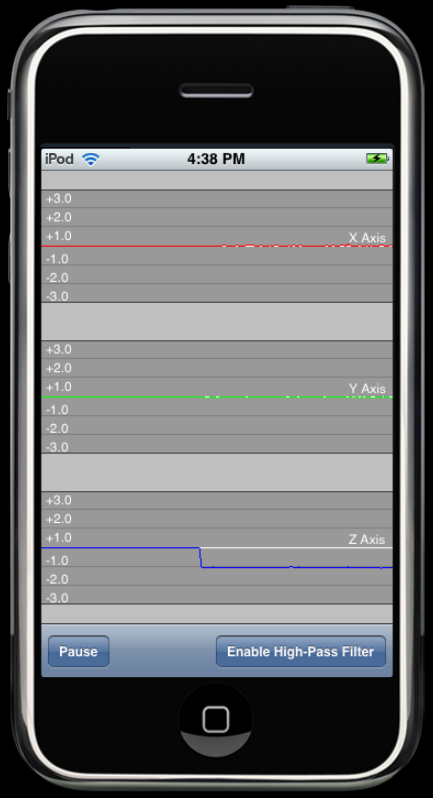
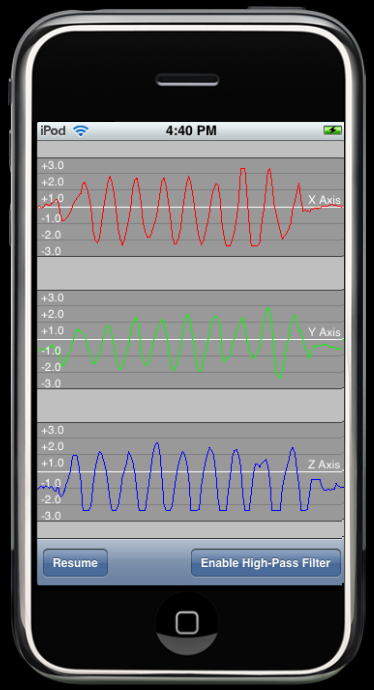


Filtering Accelerometer Data

We see something more interesting…



f(t)

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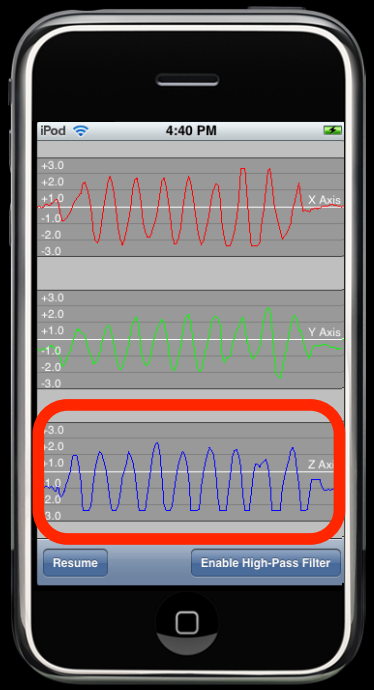

f(t)

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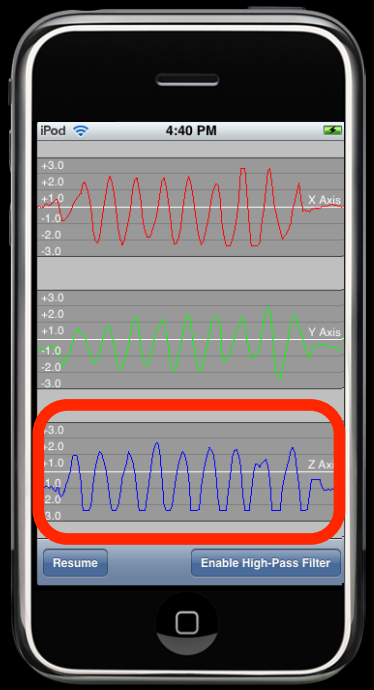

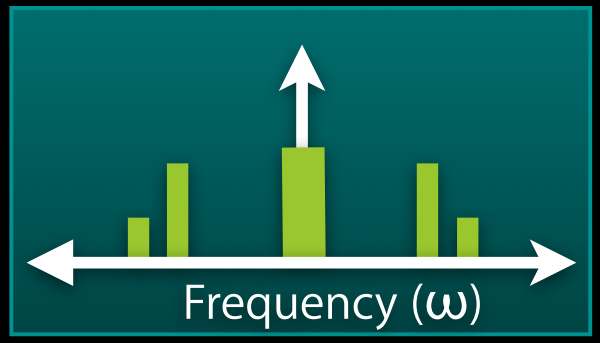

f(t)

F(ω)

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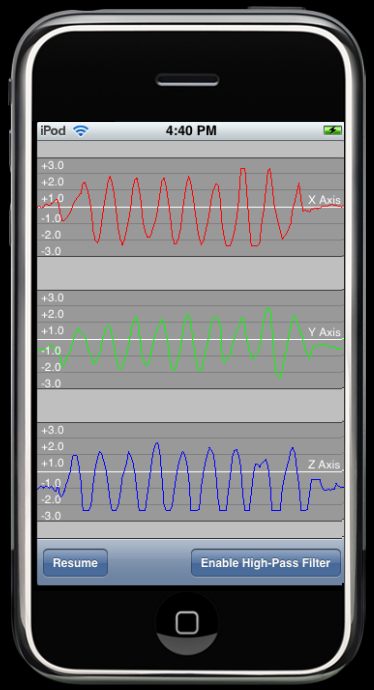
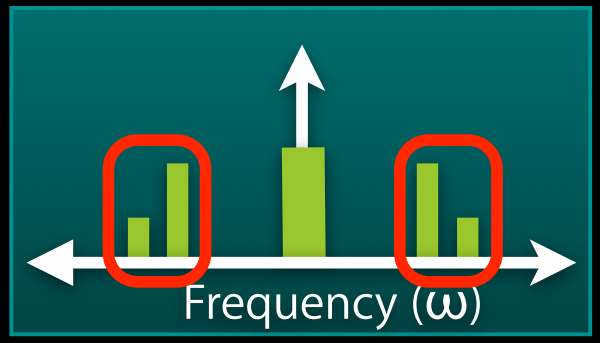


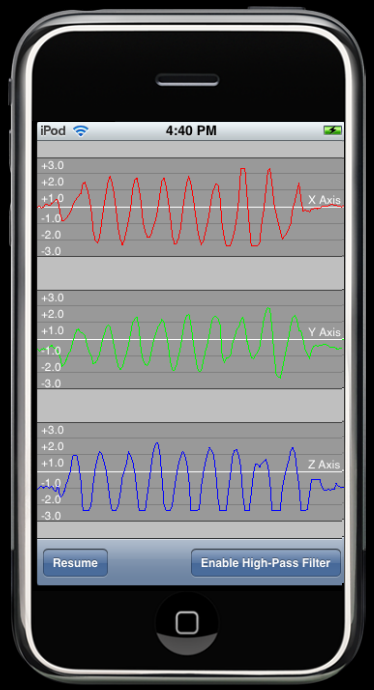
f(t)



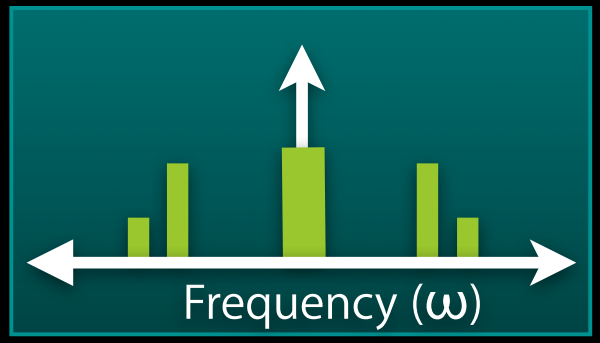
F(ω)

Filtering Accelerometer Data

Applying a low-pass filter



f(t)



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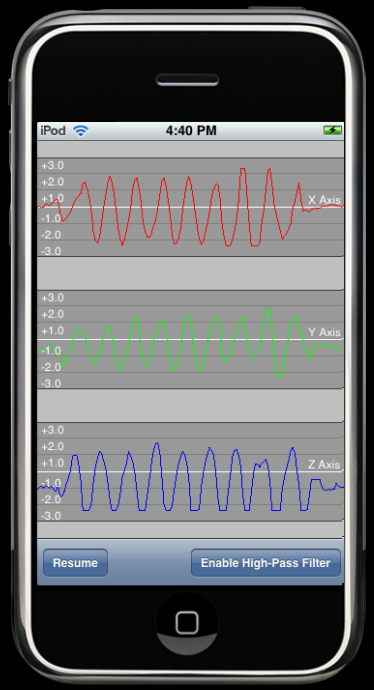

f(t)

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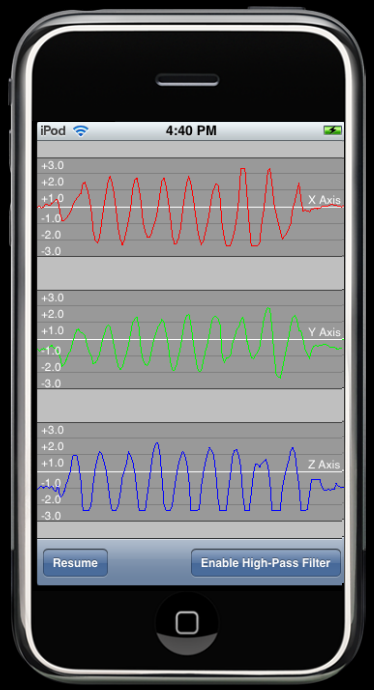

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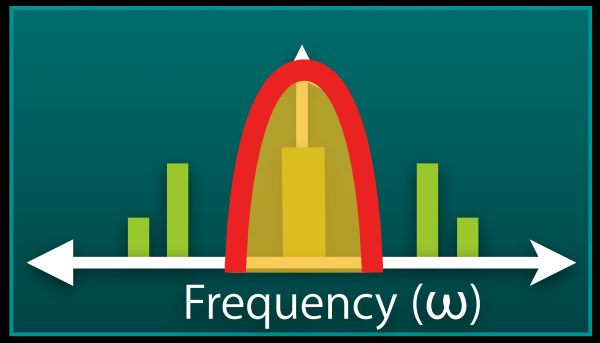


F(ω)

Filtering Accelerometer Data

Applying a low-pass filter

- Simple low-pass filter example

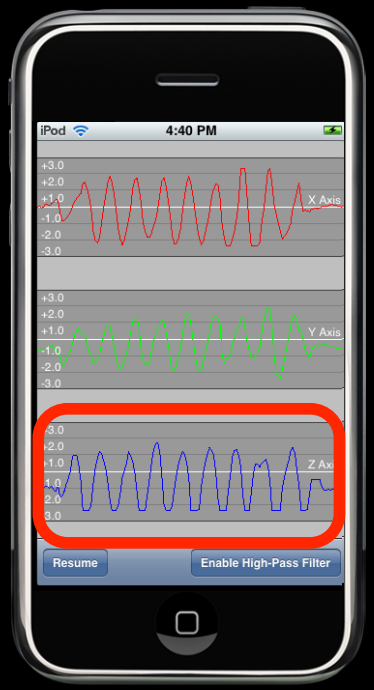
```
#define FILTERFACTOR  0.1

value = (newAcceleration * FILTERFACTOR) +
        (previousValue * (1.0 - FILTERFACTOR));

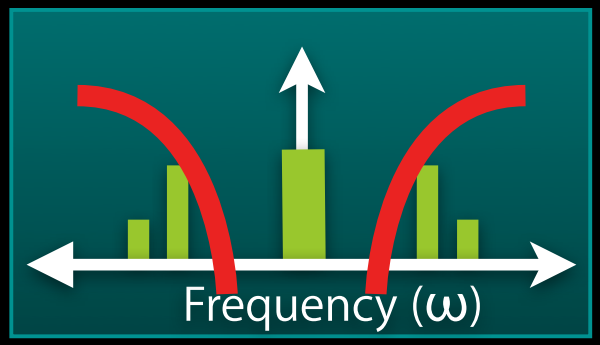
previousValue = value;
```

Filtering Accelerometer Data

Applying a high-pass filter



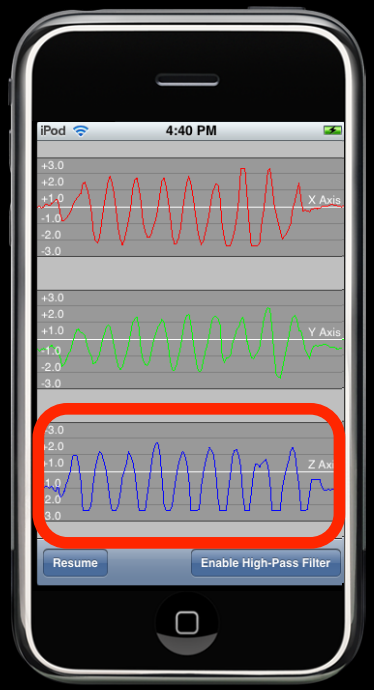
f(t)



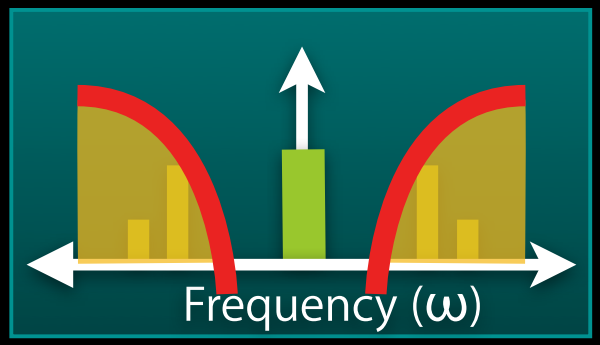
F(ω)

Filtering Accelerometer Data

Applying a high-pass filter



f(t)



F(ω)

Filtering Accelerometer Data

Applying a high-pass filter

- Simple high-pass filter example

```
#define FILTERFACTOR  0.1

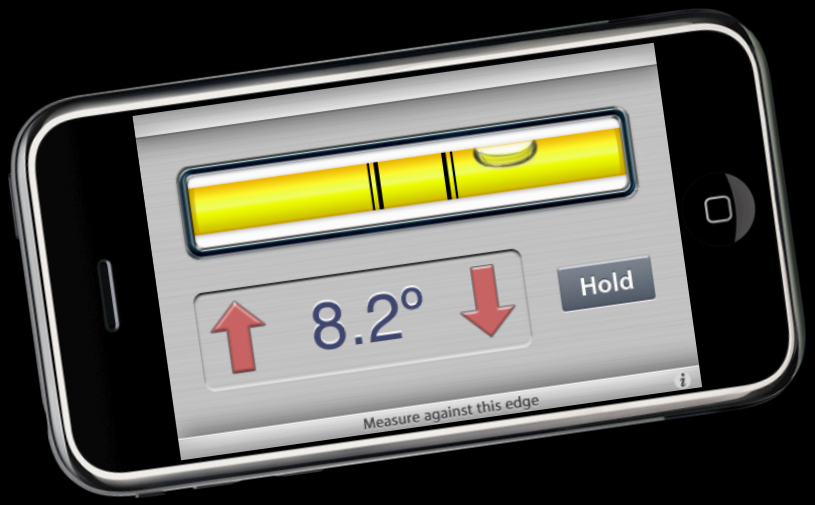
lowPassValue = (newAcceleration * FILTERFACTOR) +
               (previousValue * (1.0 - FILTERFACTOR));

previousLowPassValue = lowPassValue;

highPassValue = newAcceleration - lowPassValue;
```

Filtering Accelerometer Data

Bubble Level sample (low-pass filter)



Demo

Filtering Accelerometer Data

Bubble Level sample (low-pass filter)

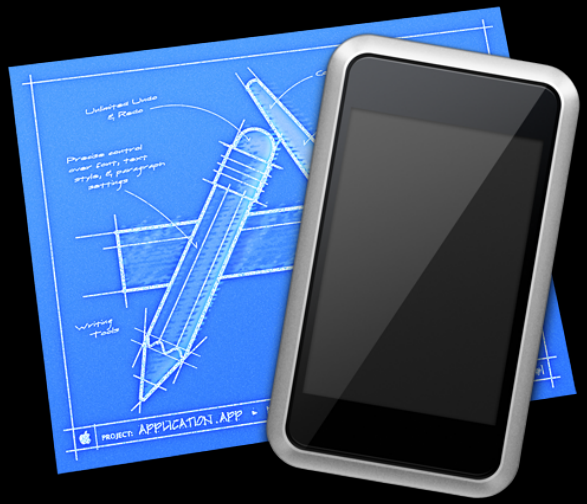
```
- (void)accelerometer:(UIAccelerometer*)accelerometer
        didAccelerate:(UIAcceleration*)acceleration
{
    accelerationX = acceleration.x * kFilteringFactor +
        accelerationX * (1.0 - kFilteringFactor);
    accelerationY = acceleration.y * kFilteringFactor +
        accelerationY * (1.0 - kFilteringFactor);

    currentRawReading = atan2(accelerationY,accelerationX);
    float calibtratedAngle = [self calibratedAngleFromAngle:
                currentRawReading];

    [levelView updateToInclinationInRadians:calibratedAngle];
}
```

Demo

No Simulator Support



Key Tips

Using the Accelerometers Effectively

- Use UIViewControllers
- Use filters to isolate raw data components
- Disable accelerometer updates when not needed
  - Set your accelerometer delegate to nil

Summary

- Take advantage of the device APIs, but…
- For image picker, always check source availability
- For hardware-based features, turn them off when not needed

Battery Life & Power Management

Power Management

Power Management

Small devices need advanced power management

Power Management

Small devices need advanced power management

- Total power consumption

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  - Laptops: ~20-60W

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  - iPhone: 500 mW to 2.5W

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- Clock gating and power gating

Power Management

Small devices need advanced power management

- Total power consumption
  - Laptops: ~20-60W
  - iPhone: 500 mW to 2.5W
- Dynamic clocking
- Clock gating and power gating
  - Turning blocks on and off continuously

Power Consumption

Power Consumption

Everything consumes power

Power Consumption

Everything consumes power

- Radios – up to ~2W

Power Consumption

Everything consumes power

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  - Baseband, Wi-Fi, Bluetooth, GPS

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- CPU/GPU – up to ~800 mW

Power Consumption

Everything consumes power

- Radios – up to ~2W
  - Baseband, Wi-Fi, Bluetooth, GPS
- CPU/GPU – up to ~800 mW
- Display – up to ~200 mW

Power Consumption

Everything consumes power

- Radios – up to ~2W
  - Baseband, Wi-Fi, Bluetooth, GPS
- CPU/GPU – up to ~800 mW
- Display – up to ~200 mW
- Hardware modules – ~10s of mWs

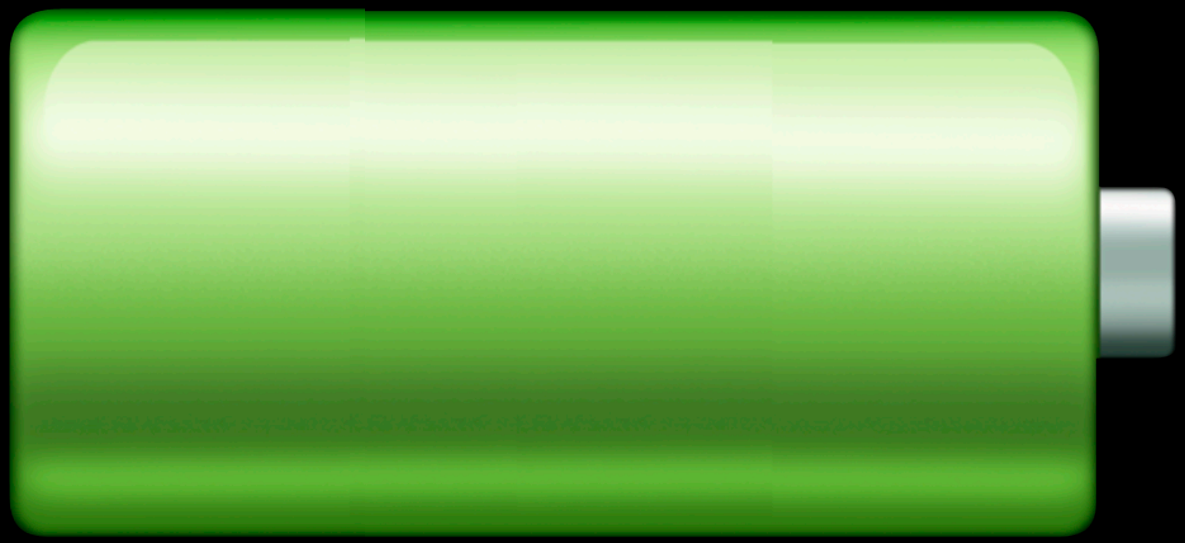
Power Consumption

Everything consumes power

- Radios – up to ~2W
  - Baseband, Wi-Fi, Bluetooth, GPS
- CPU/GPU – up to ~800 mW
- Display – up to ~200 mW
- Hardware modules – ~10s of mWs
- Keeping the system awake – enormous impact

Battery Life

Be aware of power consumption



Battery Life

Be aware of power consumption

Power Consumption - Radios

The network

- Transmitting is the most expensive operation
- Minimize the amount of transmitted data
- Avoid chatty protocols
- Transmit/receive in bursts
- Use compact data formats
- Core Location
  - Stop the location service once you have a location fix
  - Request only the location accuracy that you need

Power Consumption - CPU/GPU

All about performance

- Reduce CPU usage
- Use Sample or Shark
- Stress the GPU less – fewer layers, smaller textures, etc.

Power Consumption - Hardware Modules

Accelerometer, NAND, others

- Turn off what you don't need
- Accelerometer
  - Set the `UIAccelerometer` delegate to `nil`
  - Support orientation changes only as needed
- NAND
  - Access the disk less – use the System Usage instrument

Power Consumption - Standby

Let the system sleep

- Battery life drops from 250+ hours to <12 hours without sleep
- Don’t disable the idle timer
- Don’t play audio except when you need to

Questions?