iPhone/iPod Touch as a Data Acquisition and Control Device
By Lindrick Outerbridge & Jared Alan Frank
Introducing the iPhone

- Marketed by Apple Inc.
- Internet-able mp3 player, camera, and smartphone
- Less than 140g (5oz)
- Over 20 million sold worldwide
- Offers software development kit (SDK) for developers to write custom applications
- Fast & reliable performance
- User-friendly graphical user interface
Features and Technology

1\textsuperscript{st} Generation: quad-band GSM with EDGE

2\textsuperscript{nd} Generation added UMTS with HSDPA
(3G mobile technologies and protocols)

- Multi-touch screen
- Internal 3-axis accelerometer
- GPS
- Camera
Features and Technology

*Original & 3G:* Samsung 32-bit RISC ARM1176JZ(F)-S v1.0
620 MHz underclocked to 412 MHz
PowerVR MBX Lite 3D GPU

*3GS:* ARM Cortex-A8
833 MHz underclocked to 600 MHz
PowerVR SGX GPU

“Wi-Fi (802.11b/g), Bluetooth 2.0+EDR (3GS: 2.1),
USB 2.0/Dock connector
Quad band GSM 850 900 1800 1900 GPRS/EDGE
3G : A-GPS; Tri band UMTS/HSDPA 850, 1900, 2100
Features and Technology

- Headset controls
- Proximity and ambient light sensors
  - 3GS: digital compass
- Original & 3G: 128 MB DRAM
  - 3GS: 256 MB
- Flash memory (Original: 4, 8, & 16 GB; 3G: 8 & 16 GB; 3GS: 16 & 32 GB)
Internal Architecture

- Debug Interface
- Optional VFP
- Coprocessor Controller
- Instruction Cache
- TCRAM 0
- TCRAM 1
- TrustZone™ enabled ARM11™ core
- Data Cache
- TCRAM 0
- TCRAM 1
- Memory Management
- AMBA AXI Interface
  - Instruction Interface
  - Data Interface
  - DMA
  - Peripheral Port
Object-Oriented Programming

- iPhone is programmed in Objective-C language
- Objective-C is superset of C:
  \[ \text{Objective-C} = \text{C} + \text{Object-Oriented capabilities} \]
- In object-oriented programming:
  - Data (variables) and Operations on Data (functions) become Instance variables and Methods
Object-Oriented Programming

- Classes are defined that objects become instances of.
- Subclasses inherit properties (instance variables) and behaviors (methods) of the Superclass.

(Ex. Table and chair are subclasses of furniture class. A round table and a wheeled chair are instances of the classes with some inherited properties but with some customized properties.)
Object-Oriented Programming

- Frameworks contain broadly-defined classes to perform particular goals (Ex. Audiotoolbox framework, externalaccessory framework, coregraphics framework)
- Objects are declared as instances of an already defined (in terms of variables and methods) class
- Objects perform the methods defined by its class by sending messages to one another

Message Syntax: \[receiver\ methodname\]

Ex: \[myBox\ open\]
Each layer of the iPhone OS stack contains a list of associated frameworks that are responsible for the features and functionality of a specific technology of the phone and can be accessed through the methods of its classes.
iPhone Programming

**Xcode Tools:**

- **Xcode** - IDE; manage, edit, compile, run, and debug projects. Integrates with other tools; the main application you use during development
- **Interface Builder** - assemble your user interface visually. The interface objects created are saved to a special resource file format & loaded into the application at runtime
- **Instruments** - runtime performance analysis and debugging tool. To gather behavior/performance info and identify potential problems
- **iPhone Simulator** - simulates the iPhone technology stack to test iPhone applications on an Intel-based Mac
Mac Mini

• Cannot develop for the iPhone/iPod touch without an apple computer
• Mac mini is an affordable Intel-based Macintosh desktop
• DVI to VGA adapter needed for VGA-supported PC monitors
• 5 USB ports
• Wifi/Ethernet, Bluetooth
• Mac OS X v10.5.6 and up
What’s been done

Bluetooth and wired USB (dock connector) data transfer protocols are off limits to iPhone developers. The only inter-device communication protocol available requires WiFi connectivity. Aside from being the only hardware option for the iPhone (at the moment), OBD-II WiFi offers some technical advantages over Bluetooth and USB:

- Bluetooth headsets would be unusable during Rev operation.
- Bluetooth hardware may never work with the iPod Touch (it has a very limited subset of protocol support).
- A USB dock connection to an OBD-II device would have to replace any car-charger/music dock connectors.
What’s been done

- Military
- Medical
- R2D2 robot
- RC car
- Robot plane squad
- Packbot
Our Long-term Goals

- A remote CPU for mechatronics applications
- Data Acquisition and Control Device
- Experiment/Equipment communication
- BASIC Stamp interfacing
- Wireless sensor networks
Mobile Robot with Wireless Router
Mobile Robot
Motor Control Desktop Icon
Failure of bluetooth

- Bluetooth failed
- Jail breaking / Downgrading and the search for 3rd party apps and hacked Bluetooth
- SPP, GAP, SDAP, GOEP – the four most basic, low-level Bluetooth profiles
- SPP especially essential – sets up a virtual serial connection – most important data transfer profile. ALL SPP supported devices always communicate with each other
- FTP attempt (input and output streams [objc objects] with CFNetwork.framework (CFFTP classes)
# Supported Bluetooth

<table>
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<th>Device</th>
<th>Hands-Free Profile (HFP 1.5)</th>
<th>Phone Book Access Profile (PBAP)</th>
<th>Advanced Audio Distribution Profile (A2DP)</th>
<th>Audio/Video Remote Control Profile (AVRCP)*</th>
<th>Personal Area Network Profile (PAN)</th>
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</table>

* iPhone 3GS, iPhone 3G, and iPod touch (2nd generation) support pause, play, and stop for AVRCP.
Implementation

- Create an HTML web page using iUI Interface
- Open FTP Connection to Embedded WebServer. Upload HTML File.
iUi User Interface Framework for Safari development on iPhone

Introduction

You may also want to read Joe Hewitt’s Introductory Blog Post.

You may also want to look at the Roadmap.
Writing to Variables

Writing to variables via web page can be accomplished with HTML POST Method

<form name="iDAC" method="post"

<h2>Speaker</h2>

<fieldset>
<div class="row">
<input value="1" name="Nb_var03" type="radio">On
<input value="0" name="Nb_var03" type="radio">Off
Access a variable serially from an HTML page

Read the variable in the format variable !NB0R05

' SEROUT TX, Baud, ["!NB0R05"] ' Send Command To Read variable in Flash memory

' SERIN RX, Baud, 100, Timeout, [DEC nbvar]

Baud Rate is 2400 bps
Breadboard Circuit

Pin 0

Pin 1

Pin 2

470 Ω

Pin 3

5V

Pin 12

Pin 13

5V
Problems

- **Channel**
  - 802.11g transmits in 2.4Ghz range. The channel had to be configured to a working channel (5)

- **Timeout**
  - The servo motors drained power from our circuit causing the PINK to timeout

- **Power**
  - Separate power supplies for router and motors

- FTP 0 Bytes There is a file limit for FTP app
Future

OSC using UDP/IP & Ethernet