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iChair

DESIGN SPECIFICATION

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HISTORY

Ed. 01 PD01 Created on 11-22-2005, by Diane Chen, diane.chen@nyu.edu
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Ed. 01 PD02 Created on 12-05-2005 Modified according to review meeting based on ED01 PD01.

SCOPE

- This document gives a detailed design specification of iChair.
- This document focuses on the hardware design and data communication.

REFERENCED DOCUMENTS

Datasheets:

- 18F452
- LM386
- QT113

Web sites

- http://ipodlinux.org/Apple_Accessory_Protocol
- http://stud3.tuwien.ac.at/~e0026607/ipod_remote/ipod_ap.html
- http://www.maushammer.com/systems/ipod-remote/ipod-remote.html

We would like to thank

- Christoph, who discovered the iPod accessory protocol
- Peter Tyser who did a motion controlled iPod interface has helped us a lot.
- Maushammer who discovered the pin and dock functions of iPod remote controller.

ED	Date	Originator
01	12-05-2005	Diane Chen, Chunxi Jiang, Min Weng

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FEATURES

iChair is a new media player interface. And it works with iPod together to provide music and sound effects for customers.

- All functions are done according to users' natural gestures.
- Share users' customized selections of music aloud with others.
- Unlike all other media player, iChair require no finger movement.
- Light warning system is included in this design to gently reduce unconscious mistakes.

USER SCENARIO

- Users can plug their own iPod onto our chair, so they are not constrained to listen to the music on our iPod, they can enjoy their own playlists and music while sitting on our chair.
- After plugging in their iPod, they start playing the iPod music by simply sitting onto the chair.
- They can adjust the volume by sliding up and down the armrests. When the feel the music is not loud enough, they can put their hands on the upper part of the armrests. The lights on the armrests will start lighting upwards, indicating the volume is going up. If they feel the music is too loud, they can put their hands on the lower part of the armrests, and the lights will start going downwards, indicating the volume is going down.
- If they want to listen to another song, they can select the song they want by tapping on the sides of the chair. If they tap on the right side of the chair, they forward the music, and when they tap on the left side of the chair, they backward the music.
- The music automatically stops when they leave the chair.

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1. General

1.1 Function Blocks

iChair contains following blocks:

Power Supply: provide itself power and circuit feeding

QT: sense user gestures, convert to digital signal

OBC: on-board controller, configure other blocks, connect to QT, provide iPod interface

Light: super bright LEDs and one 20w bulb, controlled by QPROX sensors or OBC

Sound: interior speakers to play music aloud

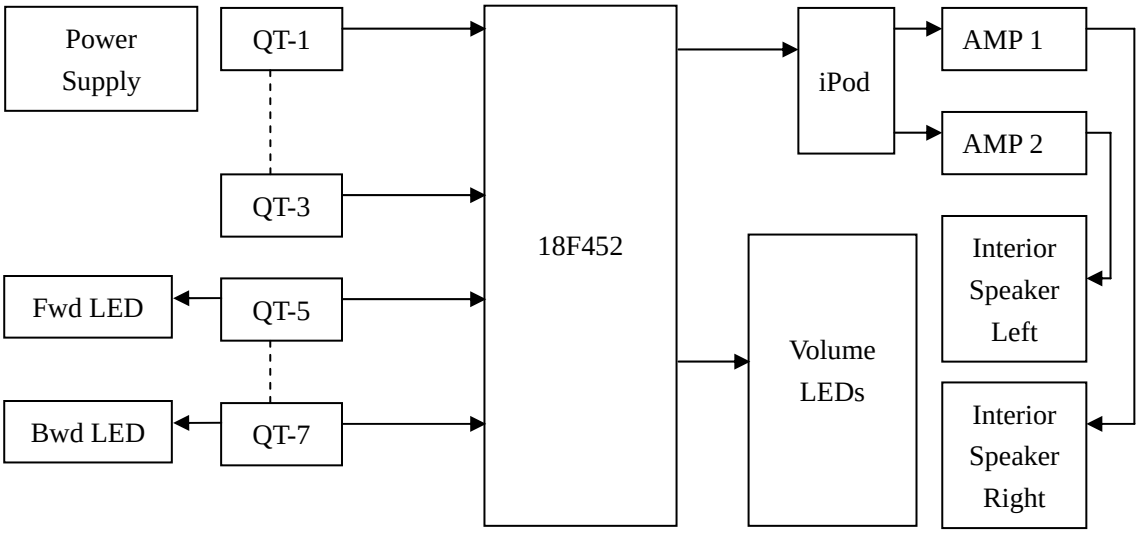

Fig 1. Function Block

1.2 iChair Interface

Exterior Interface:

- to iPod, one is to play music, and the other is to control iPod.
- to user through sensors located on different part of the chair.

2. Detailed Function Description

2.2 Power Supply

3 powers are needed by iChair, they are

$\mathbf{V_{MainLight}}$, 12V, DC supply for Main Bulb.

$\mathbf{V_{iPod}}$, 3.3V, battery supply for OBC.

$\mathbf{V_{Regular}}$, 5V, DC supply for QPROX sensors and other part

.

Output Voltage	Device	Input Voltage
12 V	A/D power adaptor	120 VAC 60Hz

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5 V	Regulator KA7805	9~15 VDC
3.3 V	iPod	None

Table 1 Power Supply

2.3 QT

2.3.1. Configuration

QT113 is adopted as sensors to detect user gesture. QT 113 senses capacity changes. It supports digital outputs.

Pay attention to QT113's output options

Tie Pin 3 to	Tie Pin 4 to	Max On-Duration
Vdd	Vdd	10s
Vdd	Gnd	60s
Gnd	Gnd	10s
Gnd	Vdd	infinite

Table 2 Output Mode Strap Options

Because of source, we have 2 different configurations. QT-1~3's idle output is high. QT-4 and 5's idle output is low.

Distribution of Sensors:

5 QT 113 are located on the chair. One is forward, and the left one is backward.

- QT-1 and 2 on the armrests are used to control volume and Volume LEDs through OBC.
- QT-3 on the center detects whether the user is on the chair or not.
- QT- 4 (on the user's right side) and 5 (left one) are used as forward and backward respectively, and they control the corresponding lights directly.

Functions of QTs:

- QT-1~4 are used to control volume and they are located on the two armrests.
- QT-5 detects whether user is on the chair or not.
- QT-6 and 7 locates on left and right side of iChair, detecting claps on the chair to forward or reverse music.

2.3.2. Peripheral Setting

Since QT 113 is capacity sensor, any capacity change on pin 5 and 6 will cause it to react. And because of iChair's dimension we need to use long wires which make it more difficult to only react to claps on certain part of the chair. At first, we used shield wires which are not very easy to find. We are using acoustic wire which is shield and has left sound and right sound, so one wire can be used for 2 sensors. And metal mesh is also used to increase sensitivity.

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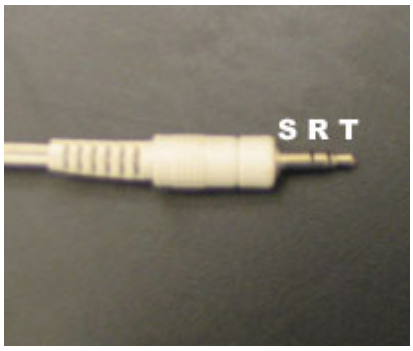

Fig 2. Shield Acoustic wire and metal mesh as sensor tips

But this kind of shield wire reduces the sensitivity of QT 113 greatly. It is already very difficult to detect capacity change outside the chair due to the thick plastic shell. And meanwhile, the wire inside the chair interacts with each other, which often cause unexpected actions.

To get out of the dilemma, we still use normal wire, and pack it with paper or plastic pipes, to prevent them from touching each other and sensitive enough to detect user gestures.

2.4 OBC

OBC configures all the peripheral devices, such as QPROX sensors, LEDS, and so on.

Two 18F452 by *Microchip* are adopted as controllers.
One (Ctrl 1) functions as iPod controller, and for reasons, please refer to 3.3.
The other (Ctrl 2) accepts data from QT and control lights according to the input signals.

Ctrl 1 <-> Ctrl 2
Because Ctrl 1 is using 3.3 V power supply while Ctrl 2 uses 5.0V, a 1K resister is used between every connection between the two controllers to pull down the voltage.

2.5 Light

Light effects are used not only for aesthetic reasons, but also as feedback when the user's gesture has triggered something. Lights also function as a warning system when something is done unconsciously.

2.6 Sound

Interior speakers adopted in iChair are just for convenience. We strongly suggest users use their own acoustic equipment, because the interior sound effect is not good.

To play music aloud, amplifiers are used here.

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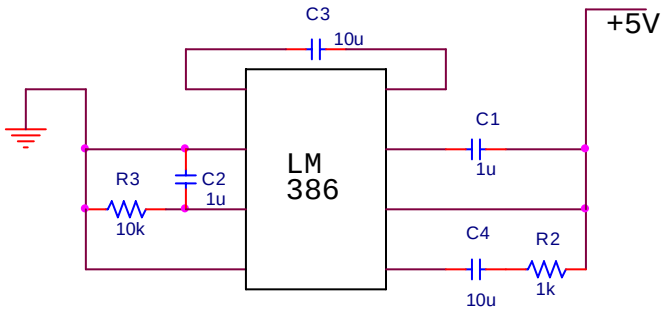

Fig 3. Sound amplifying circuits

2 speakers are used for both left and right tracks. We use headphone wire here for the speakers. The outside connection of acoustic wire is described in Fig 2. Inside the wire, there are 4 clusters of wire: Left sound (R), Left ground (S), Right sound (T), Right ground (S). To solder the shield wire, the outside copper shell must be removed. We heat the wire using soldering gun to solve this problem. And the color change is perceptible during heating.

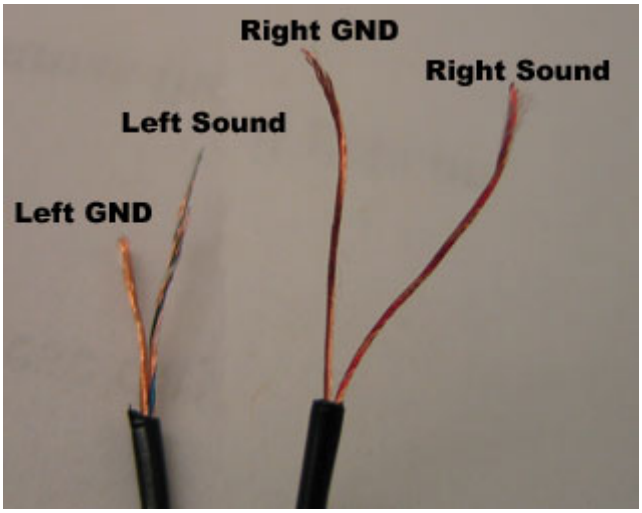

Fig 4. 4 clusters of wire in a headphone line

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3. iPod Control

3.1 Pin functions of iPod remote controller

Fig 5. iPod remote controller pin configuration

pin 4	Power to remote, +3.3v
pin 3	Digital ground
pin 2	Data from iPod (format unknown)
pin 1	Data to iPod

Table 3 iPod remote controller pin configuration

3.2 iPod Accessory Protocol

This protocol is probable suitable for iPod G3, G4, iPod Mini, and iPod photo, hopefully for iPod Nano. This protocol can also be used for the dock. See Christoph's record.

iPod remote communication is done in strings. The format is a standard 8N+1 serial structure, which means 1 start bit (low), 8 data bits, no parity bit and 1 stop bit (high). The usual baud rate is 9600.

Command strings

Button	String
Play/Pause	0xFF 0x55 0x03 0x02 0x00 0x01 0xFA
Vol+	0xFF 0x55 0x03 0x02 0x00 0x02 0xF9
Vol-	0xFF 0x55 0x03 0x02 0x00 0x04 0xF7
Skip>>	0xFF 0x55 0x03 0x02 0x00 0x08 0xF3
<<Skip	0xFF 0x55 0x03 0x02 0x00 0x10 0xEB
End Button	0xFF 0x55 0x03 0x02 0x00 0x00 0xFB

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Table 4 iPod Remote Control Command

Short description

Every byte contains one start bit (low), 8 data bits and one stop bit (high).

The first two bytes are headers. For any command, they are always 0xFF and 0x55. Perhaps the headers are used to wake up iPod.

The third is the length of next bytes (checksum is excluded), which describes how many bytes are used for mode, command and parameters.

The forth byte indicates which mode iPod is being used. For remote control, it is always 0x02.

The fifth byte and sixth byte is the actual instructions. In simple remote control mode, the first byte is always 0x00. And the second byte is different according to commands.

The seventh byte is a checksum byte which is used to prevent errors. It is calculated as:

Checksum = 0x00 – sizeof – mode – instruction – parameter

e.g. for Play/Pause 0x00-0x03-0x02-0x00-0x01=0xFA

Fieldname	Size (Byte)	Value
Header	2	0xFF 0x55
Length	1	sizeofmode +command + parameter
Mod	1	The mode the command is referring to (Look at "List of Modes" below)
Instruction	2	The two byte command
Parameter	0..n	Optional Parameter, depending on the command. 0 byte for simple remote mode.
Checksum	1	x100 - sum of all bytes between the last byte of header(0x55) and Checksum Frame

Table 5 iPod Accessory Protocol

3.3 Control

In order to control iPod by iChair, we use a microcontroller to translate signals from sensors. Here we adopted PIC 18F452, because

a) It is just at hand.
b) It is free. You can get sample from Microchip (http://www. Microchip.com)
c) It has a wide voltage range from 2-5.5V.

Actually a smaller one such as 16F628 looks much better. To choose the right chip, there are several things need to pay attention to:

a) iPod runs on 3.3V voltage, which is not very easy to acquire. So we use iPod itself as power supply. And if you use a 5V power supply, you need a voltage divider.
b) At least one digit input and one digit output.
c) It is at least 1Mhz or higher, because the baud rate of iPod is 9600.

Code for iPod control

Code for lights control