Mu.S.E.
Musically Stimulating Environment

Tim Chin
Omar Gonzalez
Ward Huang
Music player that plays custom songs and playlists based on multiple factors including:
- Lighting (artificial, natural, brightness)
- Time of day
- Weather

Read from SD Card, Streaming music (Google music, maybe Pandora), Analog in/out

Motion Detection to start playing when the user enters the room, autosleep due to inactivity (can be disabled)

Touchscreen functionality with GUI for navigating songs and editing playlists/other information

Auxiliary input and output standard 3.5mm jacks to interface with any standard input device (e.g. iPod) and any standard set of speakers.

Additional Functionality
- Android device enabled over WiFi (uses app with GUI to communicate)
- USB connection for basic mp3 device (ideally iPod or Android).
Applications

» Small, discreet, functional, all encompassing music player that has added functionality.
» Plays music automatically to set the tone of the room
» Useful in commercial practice as a consumer product
High Level Block Diagram

CPU: NXP LPC-2478

- AtoD Converter (AUX in)
- WiFi: RN171XVW – I/RM
- SDRAM: MT48LC8M8A2P-6A
- USB
- Server
- Android Device

Serial Clock, Serial Data
- Light Sensor: ROHM BH1710FVC-TR
- I2C interface
- UART interface
- Motion Sensor: Zmotion ZEPIR0AAS02MODG
- LCD interface: Serial Clock and Data
- Capacitive Touch: I2C
- LCD Touchscreen: NHD 320240MF-ATXL-CTP
- SD Card Reader

bitstream serial input bus

serial output
Responsibility

» Tim: Group leader, Software lead, networking, music
» Omar: Touchscreen, SDRAM, co-lead for board design
» Ward: Light/motion sensors, USB/SD, co-lead for board design
» All: Processor
Music Decoder Chip - VS1011

- Decodes MP3 (MPEG 1.0 & 2.0 audio layer III (CBR, VBR, ABR)); MP1 & MP2 (MPEG 1.0 & 2.0 audio layers I & II) optional; WAV (PCM + IMA ADPCM)
- Full 320 kbit/s MP3 with 12.0 MHz external clock
- Streaming support for MP1/2/3 and WAV
- Bass and treble controls
- Operates with single 12 - 13 MHz or 24 - 26 MHz external clock
Parts and Specifications

» Music Decoder Chip - VS1011
  > Low-power operation
  > High-quality stereo DAC with no phase error between channels
  > Stereo earphone driver capable of driving a 30 ohm load
  > Separate 2.5...3.6 V operating voltages for analog and digital
  > Serial control and data interfaces
  > On-chip RAM for user code / data
  > SPI flash boot for special applications
  > Interrupt driven

  > Package: 28 pin SOIC 10 x 17.5 x 2.5 mm
Parts and Specifications

WiFi Module – RN171XVW-I/RM

> 8-Mbit flash memory and 128-Kbyte RAM, 2-Kbyte ROM, 2 Kbyte battery-backed memory
> UART (1 Mbps host data rate) and SPI slave (2 Mbps host data rate) hardware interfaces
> Real-time clock for wakeup and time stamping/data logging; auto-sleep and auto-wakeup modes
> Ultra-low power: 4-uA sleep, 40-mA Rx, 180-mA Tx at 10 dBm
> Configurable transmit power: 0 to +12 dBm
> 464Kbps over UART
Parts and Specifications

» WiFi Module – **RN171XVW-I/RM**

» Network support:
  > Supports ad hoc and infrastructure mode connections
  > Push-button WPS mode for easy network configuration
  > On-board TCP/IP stack
  > Over the air firmware upgrade (FTP) and data file upload support
  > Secure Wi-Fi authentication via WEP-128, WPA-PSK (TKIP), and WPA2-PSK (AES)
  > Configuration over UART or wireless interfaces using simple ASCII commands
  > Built in networking applications:
    DHCP client, DNS client, ARP, ICMP ping, FTP client, TELNET, HTTP, UDP, and TCP
Parts and Specifications

- LCD Touchscreen – Newhaven Display - NHD-3.5-320240MF-ATXL##-CTP-1
  - 320xRGBx240 resolution
  - LED backlight
  - 24 bit RGB digital RGB interface (6.5MHz)
  - Capacitive Touch Panel with Controller
  - Serial I2C clock and data
Parts and Specifications

» LCD Touchscreen – Newhaven Display - NHD-3.5-320240MF-ATXL#-CTP-1

» TFT
  > Uses SPI interface on processor
    + 3 pins: Serial Interface Chip Select, Serial Interface Clock, and Serial Interface Data
  > Molex 51296-5494
    + LCD Ribbon connector on board

» Capacitive Touch Panel
  > Uses the I2C-bus interface to communicate with CPU
    + 2 pins: Serial I2C Clock, Serial I2C Data
  > Molex 52271-0679
    + Capacitive touch panel connector on board
Parts and Specifications

SDRAM - MT48LC8M8A2P-6A

- PC100- and PC133-compliant
- Fully synchronous; all signals registered on positive edge of system clock
- Internal, pipelined operation; column address can be changed every clock cycle
- Single 3.3V ±0.3V power supply
- Clock Rate 166 MHz
» SDRAM - **MT48LC8M8A2P-6A**

- Processor and SDRAM interface through the External Memory Controller peripheral in the LPC2478
- 16 data I/O pins,
- 12 bank address pins
Parts and Specifications

» Light Sensor Module – BH1710FVC

> Supply Voltage: 3.3V
> Dimensions: 3mm by 1.6mm by 0.145mm
> Adapted to human eye responsivity
> High photo sensitivity
> I2C Interface
> Asynchronous Reset Pin
> Possible to select 2 type I2C slave-address
Parts and Specifications

» Motion Sensor – Zmotion ZEPIR0AAS02MODG

> Small form factor – only 25.5 mm x 16.7 mm x 9.5 mm
> 8-pin interface connector with two available orientations (right-angle and straight)
> Wide 5m x 6m, 60-degree detection pattern
> Simple hardware- or advanced serial (UART)-based configuration and interface
> Adjustable sensitivity and output activation time and support for Ambient Light Sensor input
> Unique Hyper Sense feature automatically increases sensitivity after motion is detected
> Motion Sensor – Zmotion ZEPIR0AAS02MODG

- SLEEP Mode for low-power applications
- Minimal components ensure high reliability (no electrolytic capacitors)
- Modify the application code to suit your own application requirements
- 2.7V to 3.6V operation from 0°C to 70°C
- Right angle edge mounted
Parts and Specifications

Schematic Layout Example

- Light Gate receives an input from a photocell that determines brightness in the room
- Sleep Pin tied to GPIO in the processor
- Reset tied to the CPU reset.
Parts and Specifications

» SD Card Connector
» Uses the SD/MMC interface
Parts and Specifications

» USB Connector

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<thead>
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<th>Pin</th>
<th>Name</th>
<th>Cable color</th>
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<td>+5 V</td>
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<td>Data –</td>
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<td>3</td>
<td>D+</td>
<td>Green</td>
<td>Data +</td>
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<tr>
<td>4</td>
<td>GND</td>
<td>Black (blue*)</td>
<td>Ground</td>
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Voltage signal in the differential pair
Differential decoding
NRZI decoding
Packet format

» 3.3V to 5V Step-up Example
Parts and Specifications

CPU – NXP LPC2478

- ARM7TDMI-S processor, running at up to 72 MHz.
- 512 kB on-chip flash program memory with In-System Programming (ISP) and In-Application Programming (IAP) capabilities. Flash program memory is on the ARM local bus for high performance CPU access.
- 98 kB on-chip SRAM
- LCD controller, supporting both Super-Twisted Nematic (STN) and Thin-Film Transistors (TFT) displays.
- General Purpose DMA (GPDMA) controller on AHB that can be used with the SSP, I²S-bus, and SD/MMC interface as well as for memory-to-memory transfers.
- Program via edge-mounted UART RS-232 connector
Technology and IP Reuse

» LPC-2478 ARM7 CPU
» Roving Networks WiFi module
» Newhaven Touchscreen module
» Motion Sensor
» Light Sensor
» Music Decoder Breakout Board schematic
Critical Design Elements

» Music Decoder
  > If the music functionality doesn’t work then we essentially have a big paperweight with a nice screen

» Light sensor
  > Necessary to choose specific songs/playlists

» Touchscreen with GUI
  > Required for user interface with device

» At least one form of non-volatile storage
  > Must read the music from some source. Design includes SD Card reader, USB port, and streaming via Wi-Fi
## Bill of Materials

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<th>Quantity</th>
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» Questions?
» Comments?
» Concerns?