Wireless Video Chat System

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Tim O’Leary
Greg Ferreri
State of the Art

- D-Link’s “i2eye” videophone
  - 30 fps
  - Remote Control
  - Caller ID
  - Standalone (no PC required)
i2eye Drawbacks

• Not wireless
• Requires broadband Internet connection
  – $40/month * 12 months = $480/year
• Requires a TV and telephone
  – The user must use a telephone handset to send and receive audio
• No storage capability
• $299
D-Link’s Drawbacks, con’t.
What would a device need in order to compete with D-Link?

- Wireless
- Integrated display
- Integrated speaker
- Integrated storage
- Low power
- Lightweight

...and inexpensive
Marketing Feasibility Study

- **GOAL:** Priced $399 or less
- **Justification:** with products like the D-Link selling for $299, it is unlikely that consumers would pay more than $399 for the convenience of a portable device.
- **Considerable market share will be lost to PDAs**
Product Specifications

• Modes of Operation:
  – Wireless
  – Storage capability
  – Remote surveillance

• Features:
  – Integrated LCD display
  – Low power consumption

...how is it possible to keep the net cost below $400?
The FPGA Solution

- Allows for IP Core implementation
- An effective way of minimizing development and retail costs
- Reliable, proven designs
  - OpenCores.org
- Upgrade potential
  - EPROM
MPEG Codec: Cirrus Logic CS92288

- Programmable RISC core
  - Provides customized multiplexing/demultiplexing for a variety of applications (VCD, SVCD, DVD, etc)
- Programmable DSP core
  - Supports dual-channel Dolby Digital encoding and MPEG (all layers) audio encoding and decoding
- Real time MPEG-2
- Constant and one-pass variable bit rate
- Supports multiple resolutions and scan rates
- Based on embedded ARC core
  - Stands apart from traditional RISC processors because its instruction set can be configured to match the customer's exact requirements.
Video Compression Engine

- MPEG-2 Video
- NTSC formats (required for our LCD)
  - 352x240, 176x112, etc
- Programmable encoding parameters:
  - User defined quantization matrices
  - Average bit rate
Audio Compression Engine

• Programmable DSP provides several choices:
  – MPEG-1
  – MPEG-2 (all layers)
  – Dolby Digital
  – MP3
  – Additional enhancements (not needed for our device)
    • DTS
    • Dolby Pro Logic
Cirrus Integrated Multiplexer

- Programmable
- Supports encoding and decoding of:
  - DVD
  - VCD, SVCD
  - Elementary streams
  - Program streams
  - Transport streams
  - Useful for environments where errors are likely
Bill of Materials

- CCD Camera
  - $42.95
  - 1/3" CCD image sensor
  - Horizontal resolution: >350 lines
  - Sensitivity: 0.7 lux/F2.0
  - Video output: 1Vp-p, composite video 75 ohms
  - Power supply: 12VDC
  - Power consumption: 110mA
  - Size: 1.3"L x 1.3"W x 1.2"H
Bill of Materials, Con’t.

- 2.5” TFT LCD Module
  - $55.00 (quantities of 1000+)
  - Resolution: 480 x 234 dots
  - Backlight: cold cathode fluorescent lamp
  - Power source: 12VDC @ 400mA
  - Tint, color and brightness adjustable
Bill of Materials, Con’t.

- Speaker -- $0.65
- Microphone -- $0.39
- Altera Cyclone EP1C3 FPGA -- $4.00
  - Configuration PROM -- $0.49
- Sandisk WiFi/Flash combination card
  - Provides 802.11b and 128MB Flash memory in a single card
  - $129.95 retail, unknown volume discount
    - (est. $119.95)
- PIC16F877 Microcontroller -- $7.50
- Cirrus Logic CS92288 -- $29.00
Bill of Materials, Total

- All Components, plus $10.00 for PCB and packaging (housing) costs
  = $269.93

…batteries not included, of course!
Controller Unit and Memory:
Specification, Implementation, and Simulation

- **Controller**
  - Coordinates and supervises activities of subunits
- **Memory**
  - Records incoming messages
  - Organized into pages
Specification

• Basic Functions
  – Respond to user commands (play, delete, etc)
  – Interact with APU/VPU
  – Interact with memory
  – Interact with Flash/802.11b module
VHDL Implementation

Mem_pkg.vhd

Mem_bank.vhd

Selector.vhd

Memory.vhd

controller.vhd
Synthesis (Memory)
Memory (detail)
Controller – Block Diagram after Synthesis
Controller – RTL Schematic after Synthesis
Controller – RTL Detail
Encoding Demo

- Original Hi-Res MPEG (26.3 megabytes)
  - 29.97 fps
Compression Simulation

Output:

- 176x112 @ 30 fps
- 5.5 megabytes
Compressed Video

• 5.5 megabytes (compare to 30 megabytes for the original)
• Still 29.97 fps @ the same resolution
• Video quality is only marginally degraded
• Audio quality is noticeably degraded, but it would be sufficient for speech quality