Abstract

• Design a system to replace loose-leaf notebooks in school and the workplace.
• Paper notebooks offer incredible flexibility, but are environmentally wasteful and become difficult to store after a prolonged educational or occupational career.
• Our system will incorporate current display and interface technologies to provide a writing surface as intuitive and useful as paper, with electronic storage and processing options to simplify use.
What’s wrong with paper

- Occupies physical space – storage becomes tough
- Near impossible to develop automatic searching systems
- Environmentally costly
What’s right with paper

• Physically resilient
• Can contain any type of information
• Wide viewing angle, ultra-high resolution
PEN Design Objectives

- Durability – physically tough
- Portability – light and convenient size
- Longevity – long battery life
- Viewability – wide angles and brightness
- Applicability – useful for many types of info
- Storage – memory for many “sheets”
Interface

- *Paper* mode for writing and reading
- *Settings* mode for changing unit settings
- *Page browser* for switching internal pages
- *File browser* for moving pages on and off

- Modes are accessed via external buttons; files and menus are accessed on the screen
• Aside from the user interface, the PEN will incorporate three well-developed computing solutions:
• Memory management will be performed by an onboard microcontroller, moving information between the screen and internal memory;
• Image encoding algorithms will convert raw screen data into universal file formats, to allow exportation of pages as images;
• Disk management software and hardware will enable movement of page “images” from internal memory to external storage via a USB interface.
Background

• The primary reference work for the PEN is the modern “tablet PC,” an adaptation of the notebook computer that uses a touch-sensitive display as the primary user interface.
Milestones: Alpha

- Contains multiple pages stored in flash memory
- Paper mode functions – stylus can write to paper, sheets can be fully cleared
- Limited settings mode
- Page browser mode
- Deadline: 1 July 2006
Stage “Alpha”

To be completed by July 1
Milestones: Beta

- Design of 12 V DC power source based on lithium-ion battery
- Eraser input setting
- Power management software
- Deadline: 1 September 2006
Stage “Beta”
To be completed by Sept. 1

HW

Battery
Build Charger
Power Bus

SW

Ruled lines
Graph lines
Erasure

Power Warning
Loss Routines
Brightness Control
Sleep Mode

Suddenly Looses power
Impending Off
Milestones: Gold

- Image-file encoding
- File browser mode
- Full Settings mode
- USB controller and disk driver
- Plastic case design
- Circuit board fabrication
- Deadline: 1 December 2006
Stage “Gold”
To be completed by Dec. 1

HW

Case Design → Case Fabrication

Optional

Photo Cell

Speaker

Board Printing

SW

USB Activate

→ Export

→ Import

→ File Format

→ .jpg

→ File Browser
Success Metrics

• Primary concern is **resiliency**: PEN should never, ever crash
• PEN should be an attractive alternative to paper for technically-oriented professionals
• PEN should be easy and intuitive enough for my mom to use (and she’s awful with tech)
Problems

- LCD / Digitizer interfacing
- GUI development
- Power source design
- Power management algorithms
Finalized BOM

- HP/Compaq TC1100 LCD Screen and Wacom Digitizing Unit with stylus, approx $150
- HP/Compaq TC1100 LCD Backlight inverter, approx $40
- Processor/memory board – Gumstix Basix m400, $150
- Lead-acid battery, 12 V DC (to be replaced by Li in production), $35
- USB interface (onboard the Gumstix breakout gs board), $30
- External buttons
- Plastic case (to be designed in Gold phase)
- Nexcom EBK LVDS2 18/24-bit TTL to LVDS LCD transmitter module, approx $60
Testing

• Alpha:
• LCD: can be tested by programming preset patterns into the video memory.
• Digitizer: can be tested by outputting position measurements to the SCI console output built into the m400.
• Input-output coordination: tested by putting pixels at the location of the stylus input
• Page storage: tested by writing to a page, moving to another page, and recalling the previous page
Testing

- Beta:
  - Power charging: tested by draining the battery, charging it and measuring incident voltage
  - Power monitor: tested by comparing monitor output to analog measurement devices
  - Power loss compensation: tested by draining/removing the battery and verifying memory contents following power restoration
  - Power management: tested by measuring longevity with and without management algorithms
Testing

• Gold:
  • File export: tested by exporting memory contents over USB into a recognizable file
  • File import: tested by importing a file and observing a (randomized) pattern of pixels
  • File formatting: tested by exporting files that are readable to PC .jpg viewers, and importing .jpg files viewable by the PEN
  • File browser: tested by extensive situational file movement scenarios, including destination disk full, read-only, file name conflicts, and other common file system problems
  • Page browser: tested by extensive use and monitoring
Summary

- We know what we can do; we left lots of time for things we don’t know if we can do
- Job is approximately 85% software, and that suits us just fine
- All of you will want one