Parallel Interactive Image Editing

A Research Direction

Peter A. Dinda

Carnegie Mellon University

Overview

- What is image editing?
- Why is image editing interesting?
- Client-server image editing
- Research questions

What is Image Editing?

- “Photoshop”-like applications
- “Virtual Darkroom”, both more and less
- User-driven image processing

Image Editing Examples

- Whole image operations
  - Cropping, Rotation, Colorspace conversion
- Region-based operations
  - Filters
- Tool-based operations
  - Airbrushing, Burning, Dodging

Why is Image Editing Interesting?

- People care - wide use of image editing tools
- Large images = Huge memory demands
  - Film, Scanners, Digital Cameras
- Lots of parallelism to exploit
- Fine-grain user interactivity
  - Consider dodging example

Film Resolution

Film Type	Example	Low Contrast Resolution	High Contrast Resolution
ISO 100, C-41 process color negative	Kodacolor	63 lines/mm	100 lines/mm
ISO 100, E-6 process color slide	Ektachrome	63 lines/mm	100 lines/mm
ISO 25, K-14 process color slide	Kodachrome	63 lines/mm	100 lines/mm
ISO 400, black and white negative	Kodak TMAX	200 lines/mm	200 lines/mm

Film Formats

Film Format	Typical Use	Size in Pixels	Memory Required (4 Bytes/Pixel)
24mm by 36mm	Standard 35mm format	4800 by 7200	132 MB
6cm by 6cm	Portraiture, commercial	12000 by 12000	550 MB
6cm by 7cm	Portraiture, commercial	12000 by 14000	640 MB
4in by 5in	Commercial, artistic	20320 by 25400	1969 MB

(2x oversampling)

Scanners, PhotoCD

- 24bit, 600 DPI flatbeds for < $1000
  - 4in by 6in print at 600 DPI = 34 MB
- 3K by 2K 35mm film scanners $1000+
  - 3K by 2K = 25 MB
- Professional drum services up to film res.
- Kodak PhotoCD
  - 3K by 2K amateur service at $1/scan
  - 6K by 4K (100 MB) professional service

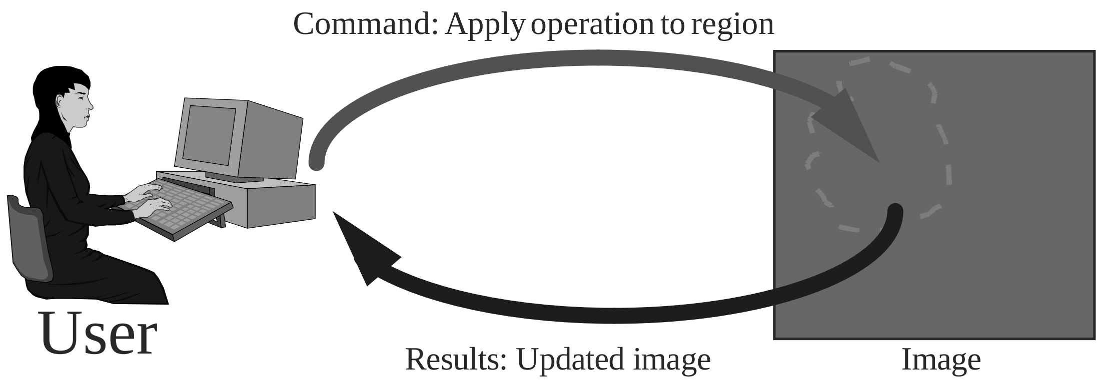
Digital Cameras

- Amateur (640 by 480), ~$1000
- Field (up to 3K by 2K), ~$10,000-$30,000
- Studio (up to 6K by 7.5K), ~$10,000-$50,000
  - 6K by 7.5K is 240 MB
- Panoramic Cameras
  - Dicomed: 6K by 52K = 877 MB

Parallelism

- Common operations
  - Pointwise operations
  - Convolution with small kernels
- Images aren't just 2D anymore
  - Layers, Channels

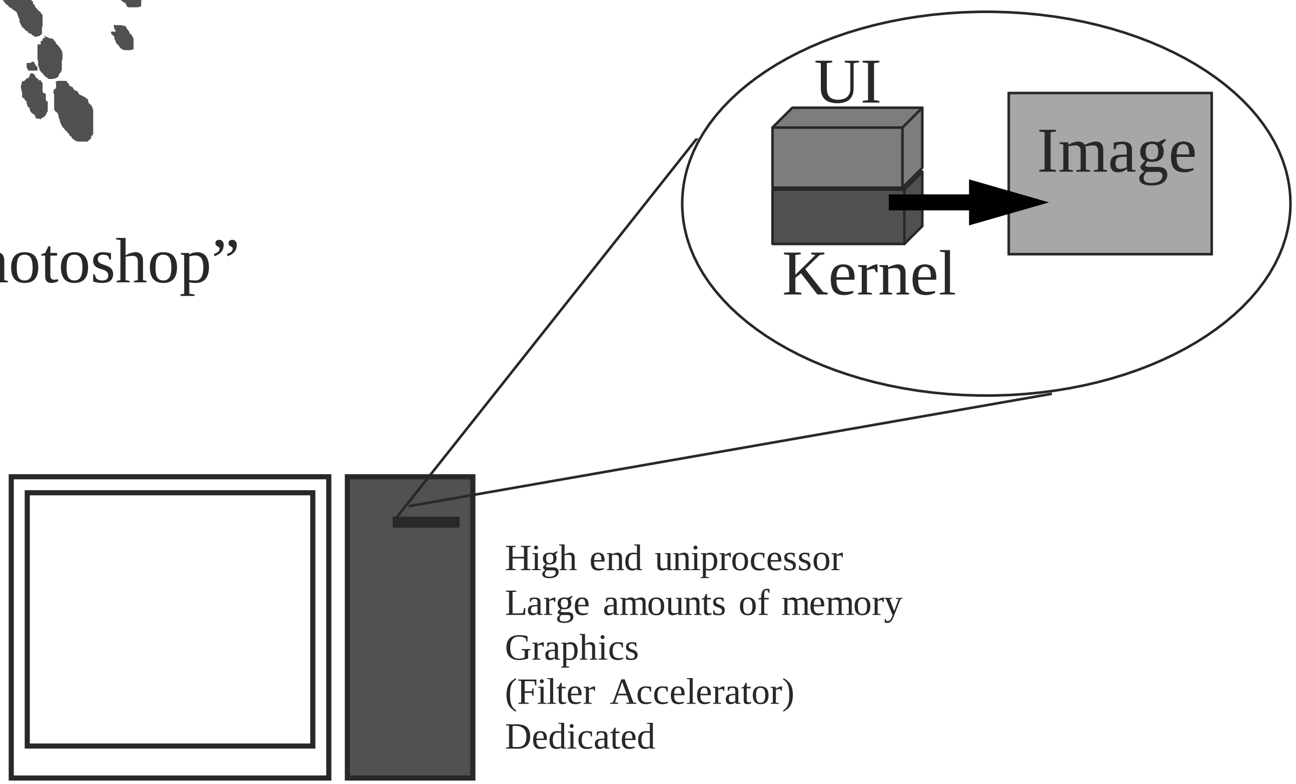
Fine-grain Interactivity



- Fast feedback necessary for correct behavior (Example: airbrushing)

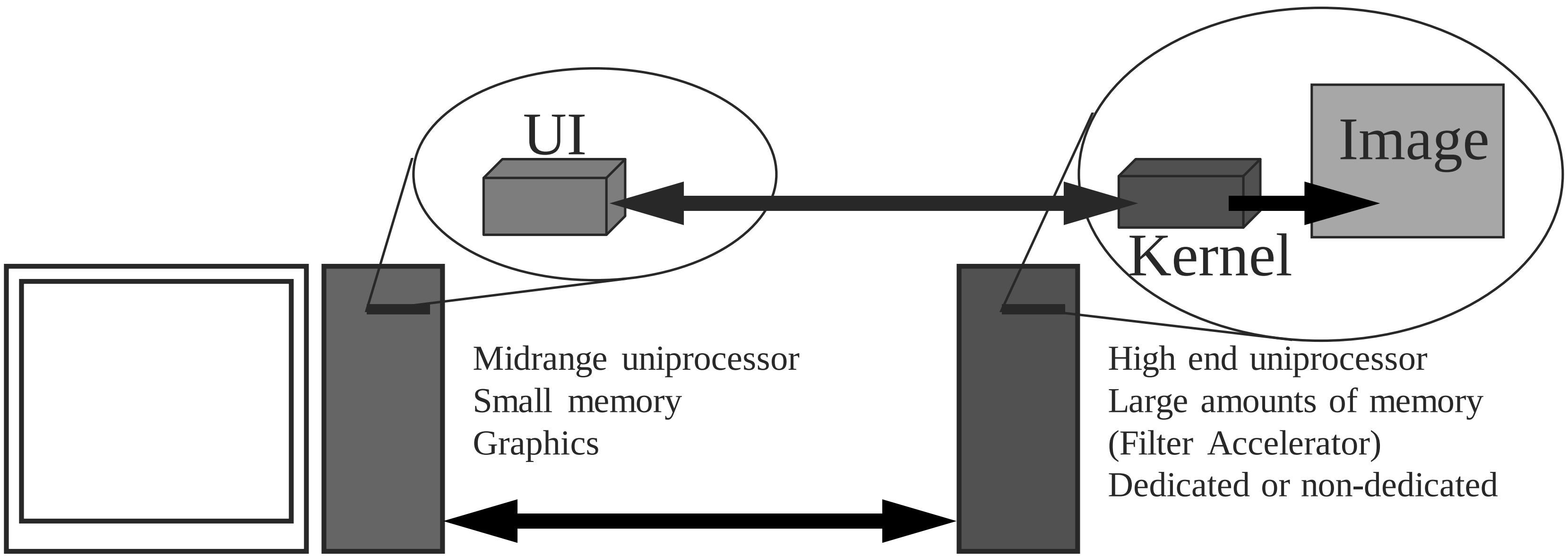
Monolithic Image Editors

“Photoshop”



High end uniprocessor
Large amounts of memory
Graphics
(Filter Accelerator)
Dedicated

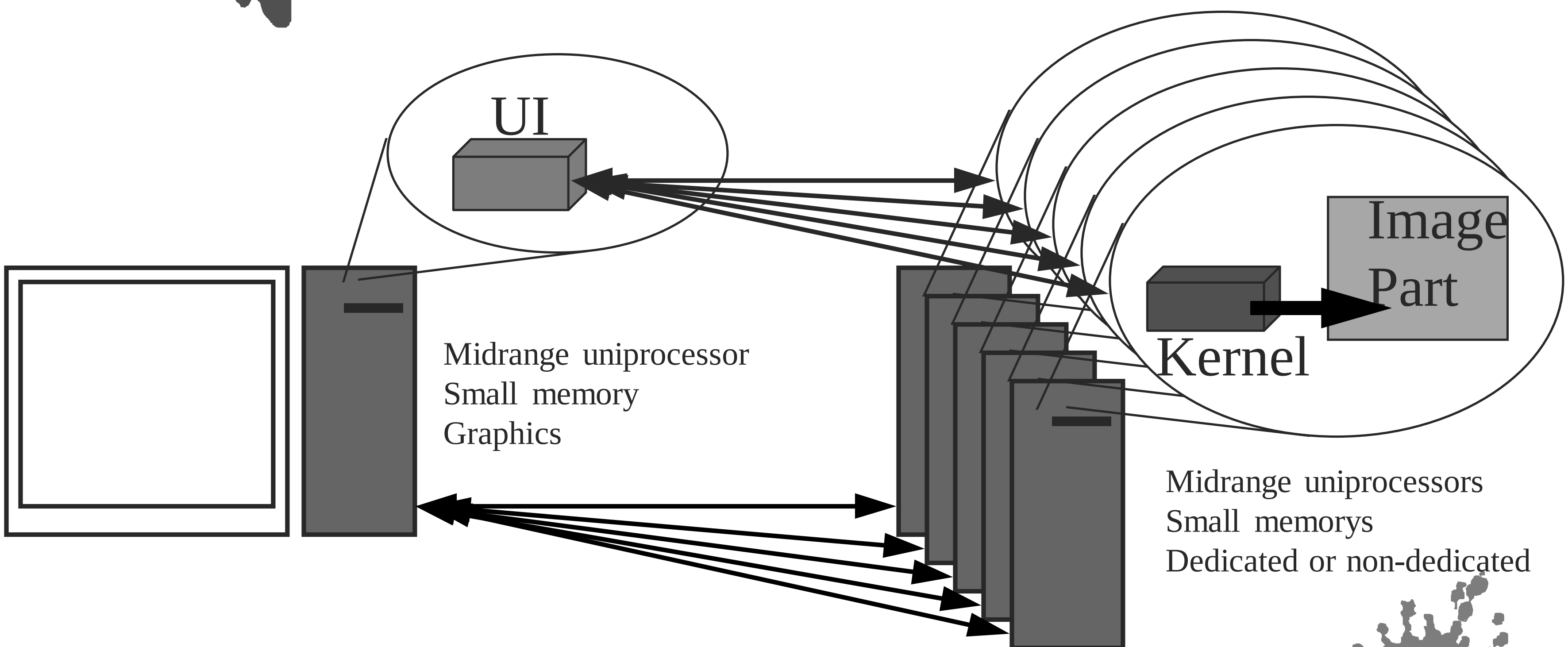
Client-Server Image Editing



Midrange uniprocessor
Small memory
Graphics

High end uniprocessor
Large amounts of memory
(Filter Accelerator)
Dedicated or non-dedicated

Client-Parallel Server



Client-Server Communication

- Client->Server traffic is small control messages
  - Arrival times unpredictable (user dependent)
- Server->Client traffic is image update bursts
  - Size dependent on visible regions of client-side windows, *bounded by client screen size*
- Round-trip must allow UI response times to be met

Goal

- Image editing client-server run-time system
- Portable, image editing class library
  - Sequential and Parallel Implementations
  - Make it easy to extend run-time system
- Extensible image editing UIs
  - Mac, Windows

Research

- Measure and characterize workload
  - Determine operations, regions, locality, response, “think time”, etc.
  - Instrument Photoshop
  - Goal: a workload generator

Research (cont.)

- Discover how to trade off between response, image quality, and network requirements
- What kinds of network guarantees are useful?

Research (cont.)

- Data distributions and load balancing for image editing
- Merging graphics regions and data distributions
- Fault tolerance
  - Networks of PCs and Macs