

# Techniques & Rationale for Motion Picture Restoration

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# Outline

- Factors driving demand for restoration
- Categories of restoration
- Motion picture restoration examples
- Open problems in motion picture image processing
- Restoration examples in detail

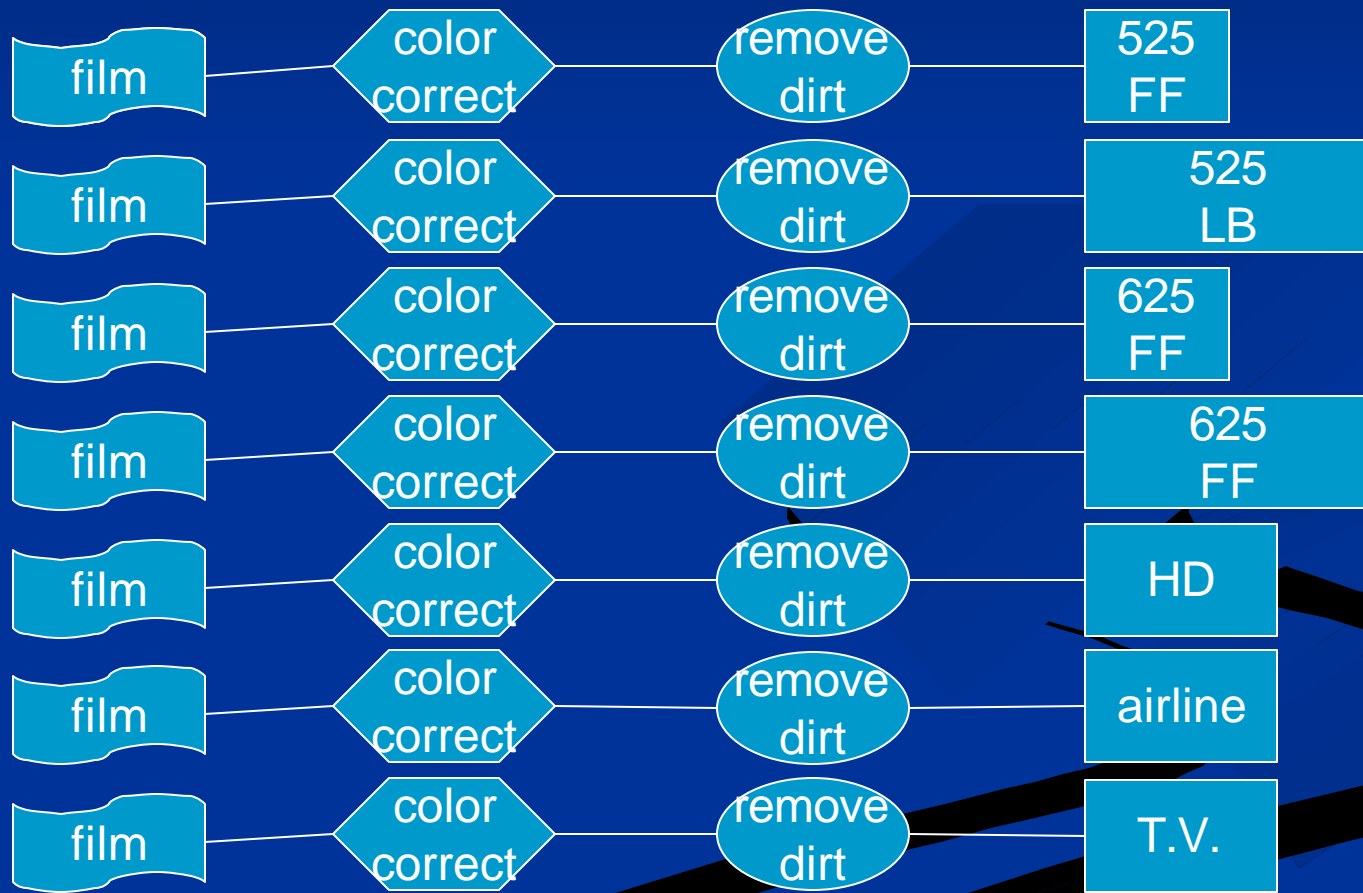
# Demand for restoration

- Film damage can be distracting
  - Dust and debris
  - Lint and hair
  - Chemical stains & water spots
  - Persistent vertical scratches
  - Cue marks (reel change indicators)
  - Finger prints
  - Film Tears
  - Splice marks
  - Customs stamps!

# Demand . . .

- Evolution of tools has raised viewer's expectations
  - Small community of creative people
  - Intense competition between facilities
  - Pride in finished product
- Post production workflow improvements have made restoration affordable

# Workflow model before 1995

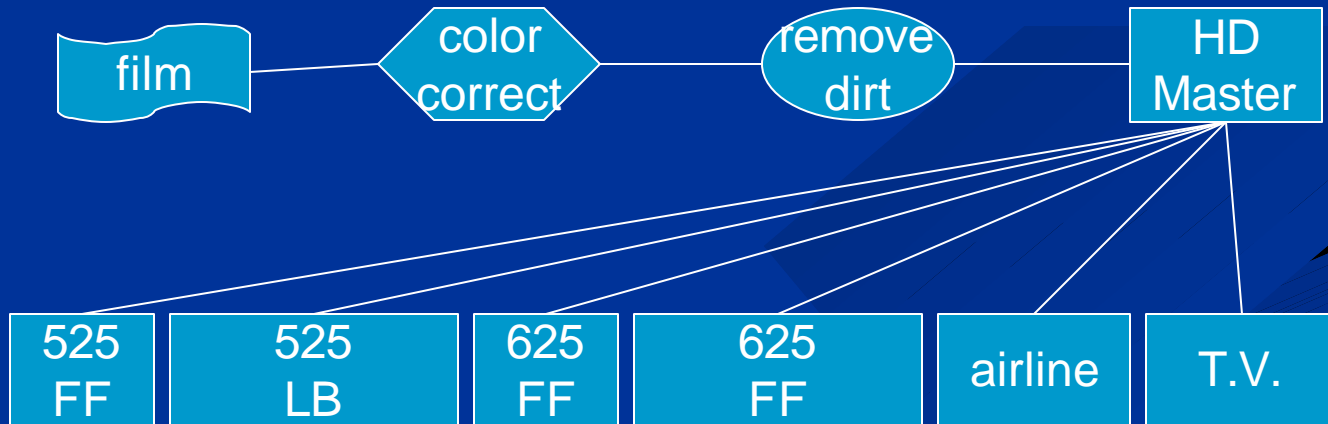


# Anecdote

- Titanic (1997)
- Huge restoration project in 1998
- 24/7 for 4 weeks. 2 systems.
- Billed 1300 hours
  
- 12 versions
- 100 hours per version

# Modern workflow

- Scan once, use many



- Typical new feature film receives about 40 hours of restoration

# Demand for restoration

- The DVD revolution
  - Excellent image quality
  - Stop and jog functions
  - Cost structure allows small or niche production runs
  - On VHS, feeble restoration efforts were adequate.  
Not so for DVD.



# Image quality continues to improve

- Digital projection in theaters
- Star Wars Episode I (1999) 10 Digital Theaters
- Star Wars Episode III (2005) 67 Digital Theaters
- My prediction: digital projection is unstoppable
  - Superior image quality
  - Reduced distribution costs (\$1200 vs. \$200)
  - Added flexibility for theater
- More demand for restoration

# Image quality

- Standard definition video is 720 columns wide
- High definition video is 1920 columns wide
- Data scans are typically 2048 columns wide
- Special effects are often 4096 columns wide
  
- Inherent resolution of 35mm film appears to be between 3000 and 4000 columns

# Categories of restoration

- New features / Episodic television
  - High volume
  - Adequate budgets available
  - Material not too distressed
    - Chemical stains
    - Isolated dirt
    - Vertical scratches
  - Utter intolerance to artifacts
  - “Crisis of Confidence” is not allowed

# Categories . . .

- Major Re-release of marquee titles
  - Few titles per year
  - Large libraries in need of preservation
  - Adequate budgets
  - Material moderately distressed
    - Heavy dirt
    - Splice marks
    - Film tears
  - Intolerance to artifacts

# Categories . . .

- Re-release of niche titles
  - High volume
  - Low budgets
  - Severely distressed material
  - Willing to compromise automation for artifacts

# Categories . . .

- Archivist preservation of historic titles
  - Careful documentation of preservation decisions
  - Generally funded by government or foundations
  - Not necessarily interested in public distribution

# Restoration examples

- Switch to Macintosh demo



# Open problems

- Better use of Grammar
  - Cuts are important for dirt removal
  - Automatic splice bump detection & repair at cuts
  - Dissolve might be useful in grain reduction
- Upconvert / super resolution
- Panning too fast for digital cinema
- Image stabilization for digital cinema

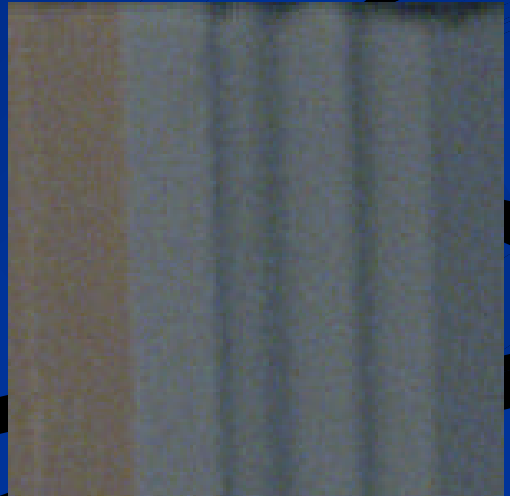
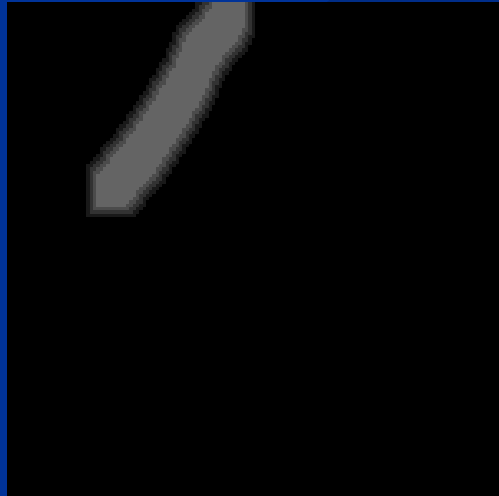
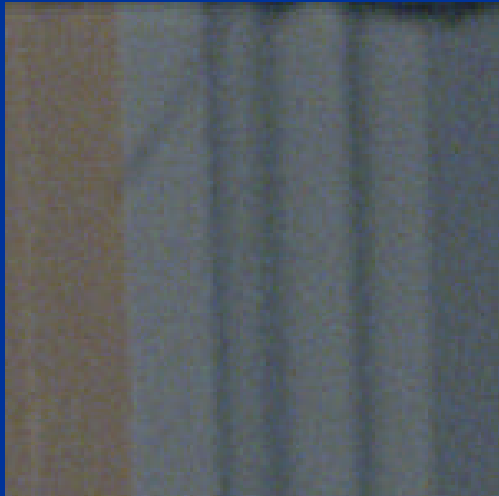
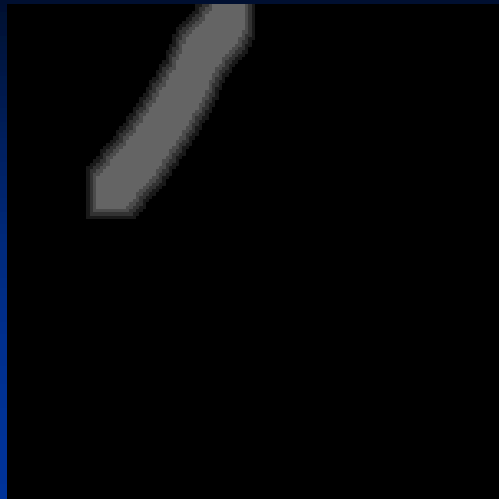


# Open . . .

- Gate hair
- “This picture came from T.V.”
- “This footage came from a cell phone”
- Motion estimation

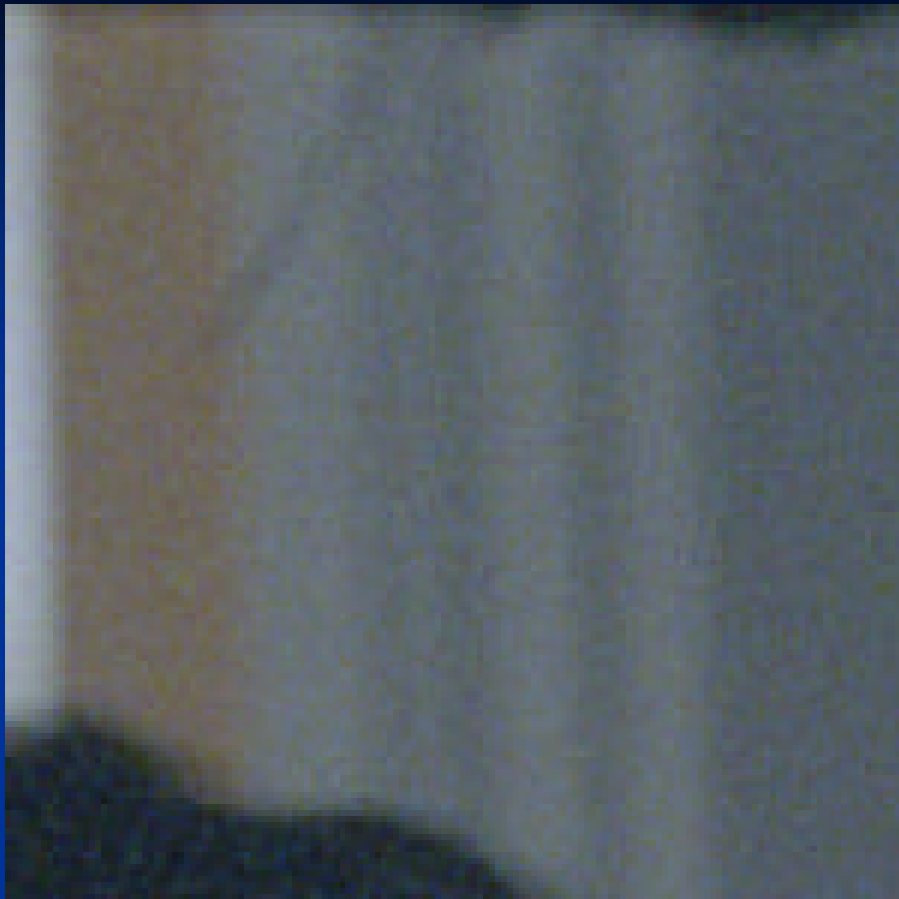
# Gate Hair

The Assassination of Richard Nixon (2004)



with Ting-Li Chen

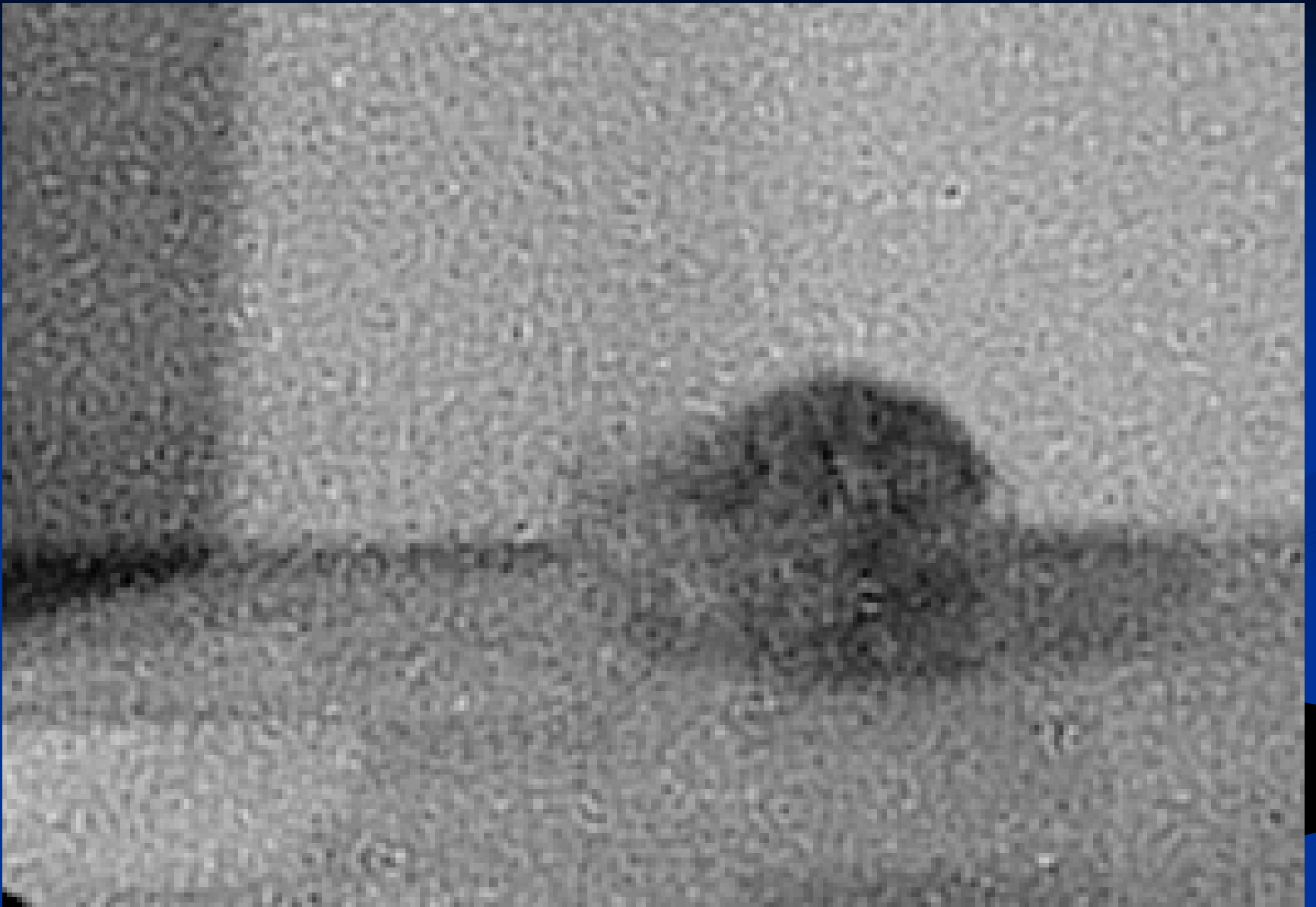




# Grain Reduction



Dr. Mabuse (1933)









# Repurpose material

- Upconvert SD material to HD. Super resolution.
- Temporal changes



# Pans for digital projection

- My prediction: audiences will be confronted with material with objectionable “judder”
- Take a lesson from animation?



The Contender

# Motion analysis

- Phase correlation
- Optical flows
- Block matching

