Rapid Non-destructive Identification of Degraded Magnetic Tape

Eric Breitung¹, Brianna Cassidy², Zhenyu Lu², Eric Bringley¹,², Samantha Skelton¹,², Stephen Morgan²

¹Library of Congress, ²University of South Carolina

23 Sept 2013

Design of Storage Architectures Meeting

Library of Congress

Preservation Research and Testing Division
THE NEED

Cultural Heritage Index (U.S.)
- 46 million tapes
  (reel to reel, VHS, DAT, cassette, etc.)
- >40% in unknown condition

Current evaluation methods:
- Visual inspection
- Playing (potentially destructive)
- If the tape squeals, flakes, breaks, or sticks to playback equipment, it is removed and treated. This process may render the playback device unusable until it is cleaned and can permanently damage the tape, which leads to loss of data.

A reliable, non-destructive identification system is not available
Spectroscopic system for differentiating degraded and non-degraded tapes:

IR spectrometer

IR spectrum

Chemometric output

Classification as non-degraded
Chemometric analysis of tapes in unknown condition vs. known LC collection tapes:

PCA Projection

- Dark blue = LC degraded
- Red = LC non-degraded
- Hunter green circle = LC degraded
- Black circle = LC non-degraded
- Purple triangle = NPR degraded
- Lt. Blue triangle = NPR non-degraded
- Lt. purple = UMD degraded
- Grey diamond = UMD non-degraded
How well does the system work for identifying degradation state?

Model: 94 tapes 1880 spectra 44D/50ND

Test Sets:
LC:  40 tapes  800 spectra     92.38%
UMD: 8 tapes  160 spectra  80D/80ND  97.5%
NPR: 12 tapes 240 spectra 160D/80ND 100%
Lomax: 4 tapes  78 spectra      78ND 100%

All data:  94.91%

Classifies well on both LC and non-LC collections!
Summary

- Differences in surface roughness identified
- Small circular surface features identified on degraded samples
  - Quantification underway
  - Possibly useful for inexpensive non-contact identification
- Confirmed presence of adipic acid in degraded tapes via GC/MS
- Chemometric analysis of IR data allows excellent categorization of both LC and non-LC ¼” tapes!

Next steps are to evaluate non-¼” formats.
What types of compounds allow the chemometrics to differentiate tapes?

Degraded dominated by alcohols and acids.
Non-degraded dominated by esters.