HIDE Technology Video Watermark for CCI and Forensic Purpose

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HIDE: Human eye Insensitive Digitally Embedded watermark
Outline

• Overview of HIDE Technology
• Background
• Piracy Model
• System Model
• Demonstration
• Conclusion
Overview of HIDE Technology

• In 2001, HIDE was proposed in response to DVD CCA’s “Request for Expressions of Interest” for watermark and met the requirements

• Features
  – Robustness against various kinds of operations and attacks
    • Especially, robust against scaling and filtering
  – Low false positive error rate
    • Meet DVD CCA’s requirement
  – Good transparency
  – Sufficient capacity for copy control usage
  – Baseband detection, independent from the compression methods and formats
Robustness/Survivability

• Robust against various kinds of attacks:
  – Vertical and/or horizontal scaling
  – MPEG-2/MPEG-4 compression and decompression
  – VHS recording
  – D/A and A/D conversions
  – Random noise addition
  – Gamma correction
  – Jitter attack
  – Rotation attack
  – Camcorder piracy
Robustness

- Rotation
Robustness

• Keystone
Robustness

- Keystone (horizontal)
Transparency

• Sophisticated adaptation based on characteristics of the original image for decreasing artifact caused by the watermark image

• Any annoying artifact can hardly be perceived in the watermarked image
Capacity

• **16 bits per several minutes**
  - Can include both CCI and forensic information
  - Can be expanded to almost infinite combinations by changing the embedded information in a certain time
• If the movie is 80 minutes long and the embedded information varies every 20 minutes, 4 kinds of information can be embedded
  (i.e. \((2^{16})^4 = 2^{64}\) combinations!!!)
Background

• Threat by camcorder piracy is growing
  – Camcorders supporting HD resolution are increasing
    → HD camcorder piracy is possible at theater
  – HD content is provided by broadcasting or next generation optical disc
  – LCD and PDP support full HD resolution
    → HD camcorder piracy is also possible at home, which is difficult to prohibit

Easy to create HD (or high quality) piracy content
Comparison of Captured Image (CRT, PDP, LCD)
HIDE Technology Video Watermark for CCI and Forensic Purpose
HD Display → HD Capture
SD Display ➔ HD Capture
Piracy Model

Theater

Broadcast

HD DVD

DVD

Internet

Camcording

Video

Audio
## Quality of Illegitimate Content

<table>
<thead>
<tr>
<th>Source</th>
<th>Video Camcording</th>
<th>Video Camcording</th>
<th>Video Camcording</th>
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<tbody>
<tr>
<td></td>
<td>Theater</td>
<td>HD DVD</td>
<td>DVD</td>
<td>Broadcast</td>
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<tr>
<td>Theater (WM)</td>
<td>HD</td>
<td>HD</td>
<td>SD</td>
<td>HD</td>
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<tr>
<td>HD DVD (WM)</td>
<td>Available after releasing movie</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>DVD</td>
<td>HD</td>
<td>HD</td>
<td>SD</td>
<td>HD</td>
</tr>
<tr>
<td>Broadcast</td>
<td>HD</td>
<td>Available after releasing DVD / HD DVD</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>
What can be Achieved by Forensic and CCI Watermark?

• Identify the theater where camcorder piracy was made
  – Precise identification of the specific theater can be made when used for forensic purpose

• Playback control against piracy can be introduced
System Model for Marking (HD DVD, DVD, Broadcast)

- Mark the content on-the-fly or off-line
  - Marking of the content can be performed by PC

![Diagram of System Model for Marking](image-url)
System Model for Marking (Digital Cinema)

- **Mark the content on-the-fly**
  - Marking of the content can be performed by PC

![Diagram of movie marking system]

- Movie Storage
- Watermark Embedder
- Theater ID
  - (Constant value throughout the movie, or varying in a certain time)
System Model for Marking (Film Theater)

- Only 16 kinds of master film are required for each reel to identify 65536 screens.

\[
65536 = 16 \times 16 \times 16 \times 16
\]
System Model for CCI Detection

Internet → Watermark Detector → ID
System Model for Forensic Mark Detection

Required once when the movie is stored, released, or the pirated content is examined.
Computational Burden

• **Embedder**
  - Realtime embedding on 4K2K 30p baseband signal (except file I/O) by Core2Duo (dual core) @2.66GHz

• **Detector**
  - Realtime detection for 4K2K 30p baseband signal (except file I/O) by Core2Duo (single core) @2.66GHz
Demonstration
Demonstration System

- Movie Storage
  - StEM (7 minutes)
- Watermark Embedder
  - 0x954A (0 to 4 min.)
  - None (4 to 7 min.)
- HD DVD Authoring
  - MPEG-4 AVC (16Mbps ave.)

- HD DVD Player
  - 47 inch Full-HD LCD
- DVD Camcorder
  - 6Mbps

Today’s Demonstration
Demonstration
Conclusion

• HIDE Technology watermark survives in camcorder piracy video
  – Applicable to forensic marking in addition to the carriage of CCI

• Toshiba is ready to provide evaluation software (embedder and detector) under contract
  – Toshiba has already integrated embedder to Toshiba MPEG-4 AVC encoder for HD DVD authoring

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