

Leaving a Mark on Digital Media

A Partial Survey of the Perfect Digital Watermark Problem

What is a Digital Watermark?

- Digital Watermark

Definition: A piece of digital information (visible or invisible) that is intended to “mark” a piece of digital media.

Purpose: To allow a respective owner can keep track of their media and also secure against certain people that wish to redistribute the media illegally.



Why do we care?

- Security
 - Prevent theft
 - Protect individual or company assets
- Ownership
 - Illegal Distribution
 - Solid, proper claims to media
- Advancements in Mathematics and Computer Science
 - Pushes advances in data compression and error detection
 - Pushes a collaboration in Mathematical fields
 - Hybrid field that has a lot of great opportunities to further our knowledge

What is a “Perfect” Digital Watermark?

- The Golden Crown of Digital Watermarks
 - Has become immune to all form of “attacks”
 - RST, Protocol attacks, etc.
 - If somehow compromised, it will destroy the media
- Well, what does it look like?
 - No idea

Theory?

General Encryption Scheme



General Decryption Scheme



What about for Perfect Watermark?

- No one knows for sure
- Lots of theories and ideas about how to build the best and most robust watermark, but no way to tell which one may lead to a perfect watermark.
- No coherent line of work to follow

The Battle Against Compression

- The greatest threat/challenge to a perfect digital watermark is data compression
 - Watermark => Redundant data added to media
 - Compression => Removal of all redundant data
 - Therefore, the perfect digital watermark must withstand compression
- Remains unsolved

Watermarking Digital Images



Watermark



Unmarked Image



Marked Image

Two Classifications:

Visible

- This type of watermark is visible on the media.
 - Has varying degrees to which it can be visible
- Most commonly used form of watermarking
- Cheap and very easy to do as an individual

Invisible

- This type of watermark is completely impossible to see on the media.
 - Cannot be seen with the naked-eye.
 - Digital Code – To – Digital Code
- Common, but more difficult to implement on the individual level.

Visible

Pros:

- Obvious ownership claim
- Can be blended into the image to make it harder to notice
- Can be made to fill the image making it challenging to remove

Cons:

- Is obviously present and can be removed with limited skill
- Can be cropped out
- Doesn't destroy media when removed
- Can be copied

Invisible

Pros:

- Have to know it's there to attack it
- Requires more technical skill on the part of the attacker to remove
- Protects all the media, not just a small portion
- Allows the option for media to be destroyed

Cons:

- Takes more advanced skill to implement (especially the more robust the watermark)
- Can have protocol weaknesses
- Can be copied

Visible Watermark Examples



Visible Watermark Examples (cont.)



Invisible Watermark Examples



What about digital video or audio?

- All schemes follow very closely from digital images
- Videos
 - **Have audio and visual component to protect**
 - Visual schemes leave audio completely vulnerable
 - Invisible schemes protect entire media
 - **Have temporal (time) component**
 - Watermarks must last the entire time length of a video
 - Allows new options
 - Moving watermarks
 - **Have three classifications**
 - Key: The key used in the watermarking scheme
 - Carrier: When the watermark is embedded (Original, encoder, compression)
 - Domain: The area where the watermark is embedded (pixel or transform)

Digital Audio (cont.)

- Audio
 - Has no visual component
 - Thus invisible watermarking is the only option
 - Nearly all schemes are identical to the ones used for images
 - Invisible watermark => Data – to – Data
 - Doesn't care what the data is about (all 1's and 0's)
 - Compression is a beast
 - Audio watermarks suffer (like all other forms) in the battle with compression.
 - Several different compression algorithms for audio
 - Some more obscure and foreign

What We Have Now for Perfect

- Not truly perfect
 - Nothing has become invincible (i.e. immune to all attacks).
- Play the Game
 - Make it so time consuming and agonizing to remove that an attacker gives up or doesn't even attempt.

So what does this all mean?

- It's hard to tell if a “perfect” digital watermark will be invented/created.
- A lot of theory and work is being done in several different directions
- The battle between watermarking and compression makes it hard for a “perfect” scheme to exist
- Watermarks are important

The World after Perfect

- Copyright Law
 - If a perfect watermark was created/invented, it wouldn't be available to the mass public
 - Individuals would most likely not have the ability or technical skills to use this type of security.
 - Thus, copyright law would remain as ambiguous as it is today.

Copyright Definitions



How do I get Copyright?

Under most national laws and international copyright treaties you receive a copyright automatically in any original work as you make it. Registration may be required to exercise some rights, like commencing a lawsuit. Copyright does NOT protect ideas. Copyright protects the expression of ideas or the ways in which an idea is materially placed or expressed in the work.



Which types of work are subject to copyright?

When a person creates an original work that is fixed in a physical medium, he or she automatically owns copyright to the work. Copyright ownership gives the owner the exclusive right to use the work in certain, specific ways. Many types of works are eligible for copyright protection, including:

1. **Audiovisual works**, such as TV shows, movies, and online videos
2. **Sound recordings and musical compositions**
3. **Written works**, such as lectures, articles, books, and musical compositions
4. **Visual works**, such as paintings, posters, and advertisements
5. **Video games and computer software**
6. **Dramatic works**, such as plays and musicals

Ideas, facts, and processes are not subject to copyright. In order to be eligible for copyright protection, a work must be both creative and fixed in a tangible medium. Names and titles are not, by themselves, subject to copyright protection.

The World after Perfect (cont.)

- So a perfect digital watermark would not affect copyright law on the individual level
- On the corporate level it would allow the absolute protection of a media from illegal distributors and would resolve all ownership issues (bye bye Megaupload)
- However, if perfect was available to everyone, what would happen?
 - Hosting sites wouldn't be able to host media
 - Would become much harder to share media on the massive scale that the internet provides today
- “No such thing as bad publicity”

Conclusion

- The Perfect Digital Watermark Remains Unsolved
 - Too many different theories being worked on
 - Compression is a beast
 - May prove more harmful than helpful
- The work being done on watermarks is vast and varying
 - Using math theories ranging from Information and Code Theory to Game Theory and Geometry
 - Everything is being explored and used
- Lots of work remains to be explored

References

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- 2.) Youtube. (2013). What is Copyright? Retrieved from <http://www.youtube.com/yt/copyright/what-is-copyright.html>
- 3.) Patel, S., Katharotiya, A., & Goyani, M. (2011). A Survey on Digital Video Watermarking. *Int. J. Comp. Tech. Appl.*, Vol 2 (6). Retrieved from <http://www.ijcta.com/documents/volumes/vol2issue6/ijcta2011020657.pdf>
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