



Quantifying Copyright Infringement in AI-Generated Images

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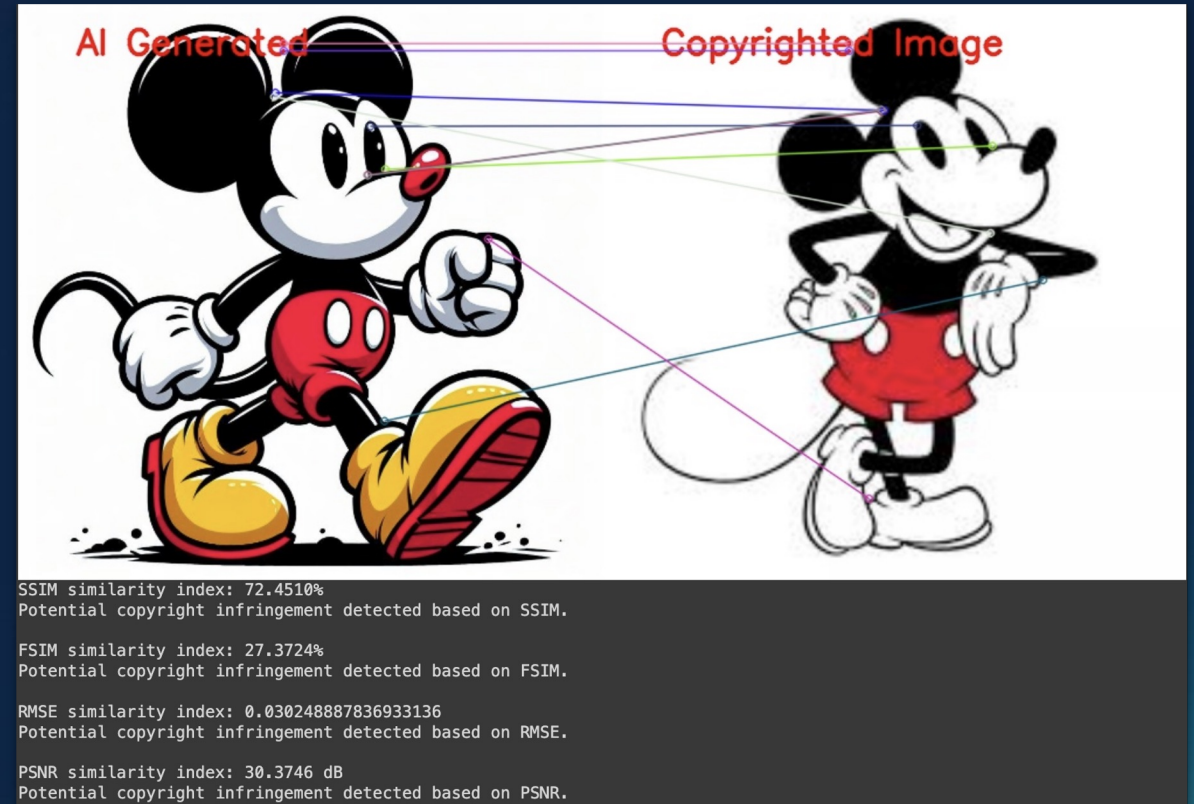
Professor: Masoud Sadjadi, PhD

Problem Definition

“The digital world is changing fast, with AI creating a lot of new content. This change makes it hard to tell the difference between images made by AI and those made by people, which can cause copyright problems. Our project looks to solve this issue by providing tools that help users understand and deal with these new challenges”

Solution

"Our solution is a user-friendly Python tool that uses math to compare AI-generated images with copyrighted ones. It calculates how similar two pictures are and provides a numerical score. High scores indicate greater similarity, which might point to potential copyright issues. This tool serves as a guide, helping lawyers and copyright holders understand the level of similarity and make informed decisions on how to proceed with potential copyright lawsuits. It's not just about identifying similarities; it's about providing a clear, math-based perspective to aid legal professionals in their analysis."



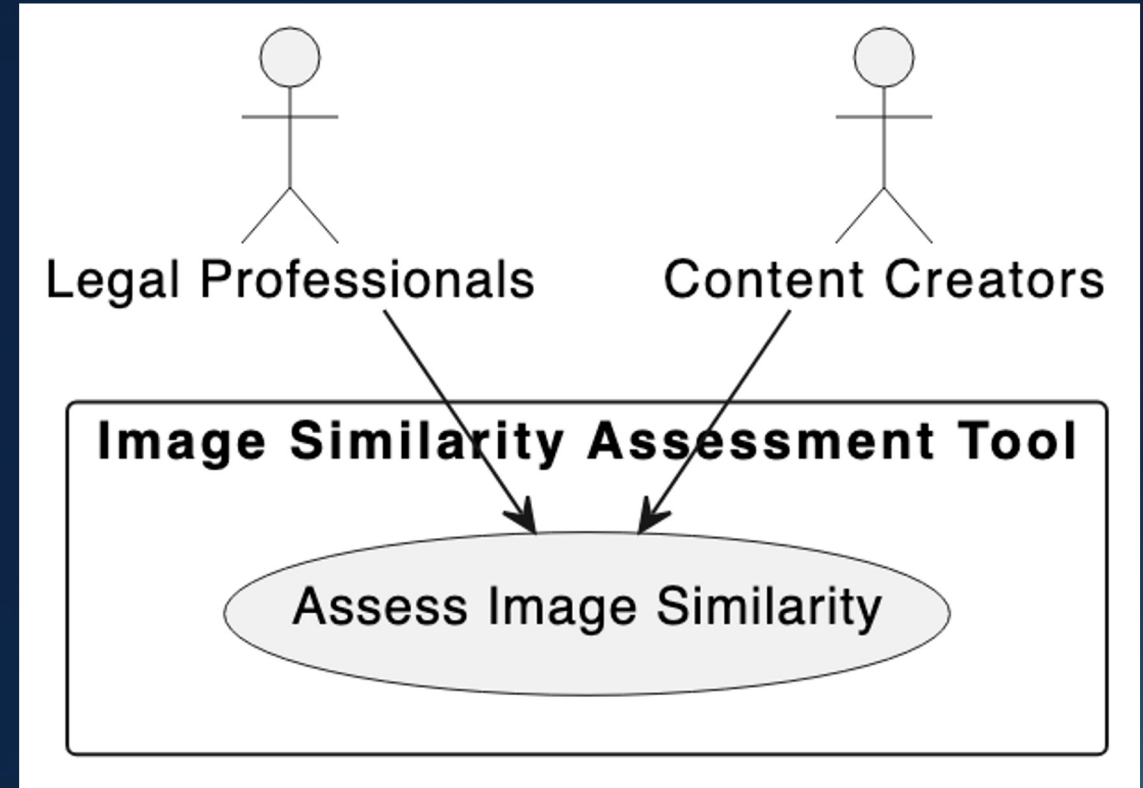
Project Management

Key Use Case:

- Use Case Name: Assess Image Similarity for Copyright Infringement Analysis
- Primary Actors: Legal professionals, content creators
- Goal: To provide a reliable, quantifiable measure of similarity between images, facilitating the identification of potential copyright infringements.

Use Case Details:

- Legal professionals and content creators initiate the tool to compare a target AI-generated image with a copyrighted image database.
- The system processes the comparison, utilizing advanced image similarity metrics.
- The tool outputs a similarity score, which the users can interpret to assess copyright infringement risks.



User Stories

Sprint 1: Project Kick-off

- Formed team and selected project topic.
- Established meeting schedules and set up documentation.

Sprint 2: Research and Planning

- Documented developments in copyright laws and AI.
- Began adapting a GitHub repo for our project's needs.
- Prepared a presentation on our research findings.

Sprint 3: Deep Dive into AI Copyright Watermarking

- Analyzed a pivotal AI copyright watermarking paper.
- Faced and documented technical challenges with code execution.

Sprint 4: Benchmark Testing

- Attempted to run Decoding Trust benchmarks.
- Explored solutions for technical difficulties, including seeking external support.

Sprint 5: Development and Testing

- Initiated the development of a program to compare two pictures and quantify similarities.
- Focused on creating a solid project infrastructure and preliminary testing.

Sprint 6: Finished Program, Set Thresholds and Drafted Paper

- Polished general code of the program.
- Set thresholds for what would be considered copyright.
- Drafted paper required by product owner.

Sprint 7: Present Project and Final Deliverable

- Present our project for Senior Design Showcase
- Prepared and turned in Final Deliverables Folder

System Design: Architecture

System Decomposition:

The system is decomposed into three main components:

- **Image Input Module:** Handles the input of images for comparison.
- **Analysis Engine:** Utilizes image processing algorithms to compare images and quantify similarities. Based on SSIM, FSIM, RMSE, and PSNR
- **Output Generator:** Displays the similarity score and detailed comparison results.

Architecture Patterns Used:

- **Microservices Architecture:** The system is built using loosely coupled services, enhancing maintainability and scalability.
- **Client-Server Model:** The frontend (client) interacts with the backend (server) where image processing and analysis are performed.
- **Model-View-Controller (MVC):** Separation of concerns is achieved by dividing the application into the model (data), view (user interface), and controller (logic).

Main Algorithm

√ Root Mean Squared Error (RMSE)

Calculating RMSE (Root Mean Squared Error), which is defined as follows:

$$RMSE(X, Y) = \sqrt{\frac{1}{mn} \sum_{i=1}^m \sum_{j=1}^n (X(i, j) - Y(i, j))^2}$$

where:

- X and Y are the two images being compared.
- (m) and (n) are the dimensions of the images, meaning X and Y have the same dimensions (m \times n).
- (X(i,j)) and (Y(i,j)) are the pixel values at position ((i, j)) in images X and Y, respectively.

RMSE is a widely used measure of the difference between values predicted by a model or an estimator and the values observed. It provides a measure of how well the model's predictions match the actual data. In the context of image processing, RMSE is used to quantify the difference between two images. A lower RMSE value indicates a higher similarity between the two images.

```
[ ] import cv2
    from image_similarity_measures.quality_metrics import rmse

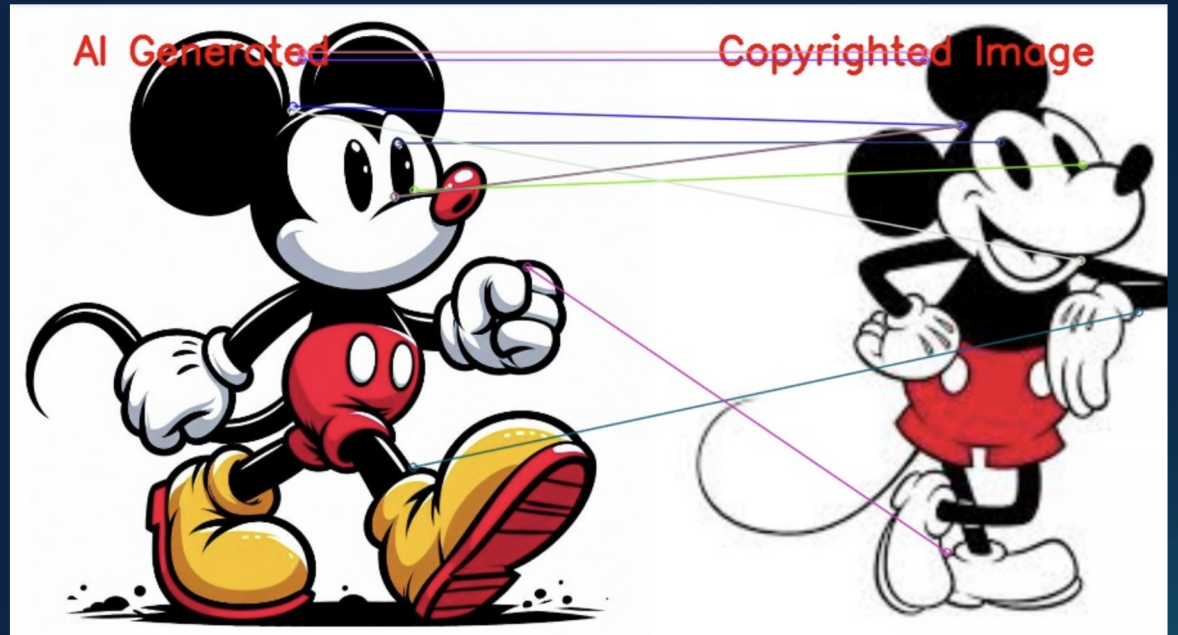
    def calculate_rmse(image_path1, image_path2):
        image1 = cv2.imread(image_path1)
        image2 = cv2.imread(image_path2)

        image2 = cv2.resize(image2, (image1.shape[1], image1.shape[0]))

        rmse_value = rmse(image1, image2)
        print(f"RMSE similarity index: {rmse_value}")

        if rmse_value < 0.04:
            print("Potential copyright infringement detected based on RMSE.\n")
        else:
            print("No potential copyright infringement detected based on RMSE.\n")

        return rmse_value
```



SSIM similarity index: 72.4510%
Potential copyright infringement detected based on SSIM.

FSIM similarity index: 27.3724%
Potential copyright infringement detected based on FSIM.

RMSE similarity index: 0.030248887836933136
Potential copyright infringement detected based on RMSE.

PSNR similarity index: 30.3746 dB
Potential copyright infringement detected based on PSNR.



Conclusion

Project Impact:

- Pioneered advancements in digital content management amidst the challenges posed by AI in copyright laws.
- Developed a tool that serves as a bridge between mathematical theory and practical application, providing clear insights into image similarity.

Core Value:

- Essential in an era where distinguishing between original and AI-generated content is increasingly complex.
- Offers a new paradigm for copyright assessment beyond traditional methodologies.

Stakeholder Benefits:

- Empowers legal professionals, content creators, and platform operators with a versatile tool for copyright analysis.
- Facilitates a proactive approach in managing copyright, allowing stakeholders to address potential infringements effectively.

Future Orientation:

- Addresses immediate needs while anticipating upcoming challenges in the copyright domain.
- Represents a beacon of interdisciplinary collaboration, merging law, computer science, and data analysis.

Readiness for Evolution:

- As AI advances, the tool is designed to adapt, ensuring continued relevance and reliability.
- Committed to supporting stakeholders in navigating the evolving landscape of intellectual property in the digital age.