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Artificial Intelligence and Blockchain-Based Intellectual Property Protection Platform

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ABSTRACT: With the rapid growth of digital content creation and online distribution, creators increasingly rely on digital platforms to manage and protect their intellectual property. However, a major limitation of existing copyright protection systems is their reliance on centralized storage and manual verification processes, which are vulnerable to tampering, inefficiency, and limited scalability. To address these challenges, this paper proposes an AI-based multimedia intellectual property protection system integrated with blockchain technology. The proposed system supports text, image, and audio content and employs Artificial Intelligence techniques to generate robust content fingerprints for originality verification. Deep learning–based feature extraction and similarity analysis are used to detect plagiarism, duplication, and partial reuse across multiple media formats. Blockchain technology is utilized to store cryptographic hashes and ownership metadata as immutable, timestamped records, while decentralized storage ensures efficient management of large digital assets. Automated similarity evaluation and threshold-based decision logic enable accurate classification of content originality, and verification reports provide transparent ownership validation. The proposed system demonstrates improved accuracy, security, and scalability compared to traditional copyright protection mechanisms, making it suitable for real-world multimedia intellectual property protection applications.

KEYWORDS: Artificial Intelligence, Intellectual Property Protection, Multimedia Fingerprinting, Blockchain, Similarity Detection, IPFS

I. INTRODUCTION

A. Overview

Rapid growth of digital technologies and widespread availability of internet-based platforms have transformed the way creative content is produced, shared, and consumed. Digital intellectual property such as images, audio files, text documents, designs, and multimedia content plays a vital role in education, research, business, and creative industries. Ease of access and low-cost distribution mechanisms have encouraged innovation, collaboration, and global content sharing.

Simultaneously, digital transformation has increased vulnerability of intellectual property to plagiarism, copyright infringement, unauthorized duplication, and illegal redistribution. Digital content can be copied, modified, and redistributed with minimal effort, often without the consent or knowledge of the original creator. Such practices result in financial losses, reduced creator recognition, and complex ownership disputes.

Conventional intellectual property protection mechanisms depend on centralized authorities, manual copyright registration, watermarking, and legal enforcement. Centralized systems often suffer from delayed verification, lack of transparency, vulnerability to tampering, limited scalability, and absence of automated monitoring. Manual enforcement processes remain time-consuming and ineffective in large-scale digital environments.

Recent advancements in Artificial Intelligence and blockchain technology offer a promising solution to these challenges. Artificial Intelligence enables intelligent analysis, fingerprint generation, and similarity detection, while blockchain technology provides decentralized, immutable, and transparent ownership records. Integration of these technologies enables development of a secure, automated, and reliable framework for protecting digital intellectual property.

B. System Description

Artificial Intelligence and blockchain-based intellectual property protection platform is designed to ensure secure ownership verification and automated plagiarism detection for digital assets. Digital content uploaded to the system undergoes analysis and fingerprint generation using specialized Artificial Intelligence techniques tailored to each content format.

Image data processing applies Convolutional Neural Networks to extract high-level visual features resilient to resizing, compression, and minor editing. Text content processing utilizes Natural Language Processing embeddings to capture semantic relationships and contextual meaning. Audio content processing employs spectral and frequency-based feature extraction techniques to generate stable and distinctive audio fingerprints.

Generated fingerprints uniquely represent content identity and enable efficient similarity comparison. Blockchain technology records cryptographic hashes, timestamps, and ownership metadata in an immutable distributed ledger. Decentralized storage mechanisms preserve digital assets off-chain while maintaining verifiable ownership references.
Smart contracts automate content registration and ownership verification, reducing reliance on centralized intermediaries. Continuous monitoring mechanisms detect unauthorized reuse and trigger real-time alerts through an administrative dashboard.

C. Objectives

The primary objective is the design and implementation of a secure, decentralized, and fully automated intellectual property protection system integrating Artificial Intelligence with blockchain technology.

Specific objectives include:

1) AI-driven fingerprinting for images, text, and audio
2) Blockchain-based immutable ownership verification
3) Advanced plagiarism and similarity detection
4) Real-time monitoring and alert generation
5) Elimination of centralized authority dependency.

II. LITERATURE SURVEY

Literature analysis reveals that blockchain-based approaches effectively address decentralized ownership management, provenance tracking, and tamper-proof record maintenance. Artificial Intelligence-based techniques provide robust fingerprinting, similarity detection, and originality verification. Existing works largely treat blockchain and Artificial Intelligence as independent solutions rather than integrated components of a unified system.

The following works highlight the existing landscape and gaps:

[1] Q. Wang et al. proposed an IEEE Transactions–based blockchain framework for managing copyrights, provenance, and lineage of digital and AI-generated assets. Immutable ownership records ensured transparency and non-repudiation; however, the absence of AI-based fingerprinting limited automated originality verification.

[2] R. Xie and M. Tang presented a copyright protection scheme published in Heliyon (ScienceDirect) using blockchain cross-chain technology to improve scalability and transaction efficiency. Although decentralized ownership registration was achieved, the framework relied on conventional similarity checks without AI-driven multimedia plagiarism detection.

[3] A. Yan et al., in an IEEE Transactions publication, introduced robustness fingerprint techniques for protecting machine learning model intellectual property. While resilience against fine-tuning attacks was demonstrated, centralized verification restricted decentralized trust.

[4] H. Nie et al. proposed compression-resistant deep model watermarking in IEEE Transactions on Artificial Intelligence. High verification accuracy was achieved under transformations, but model modification during watermark embedding raised content integrity concerns.

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[5] T. Xu et al., publishing in IEEE Transactions, developed cross-domain fingerprinting approaches for deep model intellectual property protection. Although robustness across datasets was shown, centralized verification limited scalability and decentralized ownership validation.
[6] M. Xue et al. presented an explainable intrinsic feature-based intellectual property protection method in IEEE Transactions. Improved transparency enhanced trust; however, lack of decentralized storage and automated infringement detection constrained real-time enforcement.
[7] I. Lederer et al., in an IEEE Transactions survey, systematically analyzed watermarking, fingerprinting, and attack strategies for machine learning model protection. Key robustness challenges were identified, but no deployable system was implemented.
[8] Md. M. Islam et al. proposed a consortium blockchain-based global copyright system in IEEE Transactions using Proof of Authority consensus. While transparency and governance were improved, Artificial Intelligence-based originality verification was not incorporated.
[9] X. Yi et al. introduced a digital rights management scheme published in Peer-to-Peer Networking and Applications (Springer) using redactable blockchain and perceptual hashing for image copyright protection. The approach lacked deep learning integration and multi-format content support.
[10] W. Kanakri et al., in an IEEE Transactions analytical study, examined the prospects of blockchain technology for intellectual property protection. Despite highlighting decentralization and immutability benefits, implementation details and AI integration were missing.

The key research gap identified is the necessity for an integrated platform that combines the decentralized, immutable ownership and provenance tracking of blockchain with the automated, robust fingerprinting and similarity detection capabilities of Artificial Intelligence across multiple content formats (text, image, audio). The proposed framework addresses this gap.

III. SYSTEM REQUIREMENTS AND DESIGN

A detailed analysis of system requirements, limitations of existing approaches, proposed system architecture, module design, and the overall design process adopted for the Artificial Intelligence and blockchain-based intellectual property protection framework. Emphasis is placed on scalability, automation, security, and multi-format content support.

A. Problem Definition

Rapid proliferation of digital platforms has led to exponential growth in the creation and distribution of digital intellectual property, including images, audio recordings, textual documents, and multimedia assets. While digital dissemination enhances accessibility and collaboration, it also exposes intellectual property to unauthorized duplication, plagiarism, and ownership disputes. Content can be copied, altered, and redistributed effortlessly, often without traceable attribution to the original creator.

Traditional originality verification and copyright enforcement mechanisms lack the capability to process large volumes of digital content in real time. The absence of automated, intelligent verification systems results in delayed infringement detection and unreliable ownership claims. Furthermore, existing solutions fail to provide immutable proof of content ownership with verifiable timestamps, making dispute resolution complex and inefficient.

Therefore, there exists a critical need for a secure, decentralized, and intelligent system capable of performing automated originality verification, robust fingerprinting, and tamper-resistant ownership validation across multiple digital content formats.

B. Limitations of Existing Systems

Conventional intellectual property protection systems rely on centralized repositories, manual copyright registration, and legal enforcement procedures. These approaches suffer from several inherent limitations:

1) Watermarking Vulnerabilities:

Digital watermarking introduces modifications into original content and is susceptible to degradation or removal through compression, cropping, resizing, and signal manipulation. Loss of watermark information compromises ownership verification and content integrity.

2) Centralized Architecture Issues**:**

Centralized databases introduce single points of failure and are vulnerable to unauthorized modification, insider threats, and large-scale security breaches. Trust is placed in administrative authorities rather than cryptographically verifiable systems.

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3) Lack of Automation:

Manual plagiarism detection and copyright enforcement are time-consuming and unsuitable for large-scale digital environments. Existing automated tools often operate independently and lack integration with ownership verification mechanisms.

4) Limited Content Format Support:

Many existing systems focus on a single content type, such as text or images, and fail to support multimedia assets comprehensively.

5) Absence of Continuous Monitoring:

Traditional systems do not provide real-time monitoring or alert mechanisms, leading to delayed detection of unauthorized reuse.

These limitations highlight the necessity for a decentralized, automated, and intelligent intellectual property protection framework.

C. Proposed System Overview

Proposed system integrates Artificial Intelligence and blockchain technology to provide end-to-end protection for digital intellectual property. Artificial Intelligence techniques generate unique and robust fingerprints for text, image, and audio content without altering original data. Blockchain technology ensures immutable ownership registration, transparent verification, and non-repudiation.

System adopts a decentralized architecture where digital assets are stored off-chain using InterPlanetary File System (IPFS), while cryptographic hashes and ownership metadata are securely recorded on the blockchain. Smart contracts automate ownership registration, verification, and transaction validation processes, eliminating dependency on centralized intermediaries.

Automated similarity analysis enables plagiarism detection, and continuous monitoring mechanisms generate real-time alerts when infringement thresholds are exceeded.

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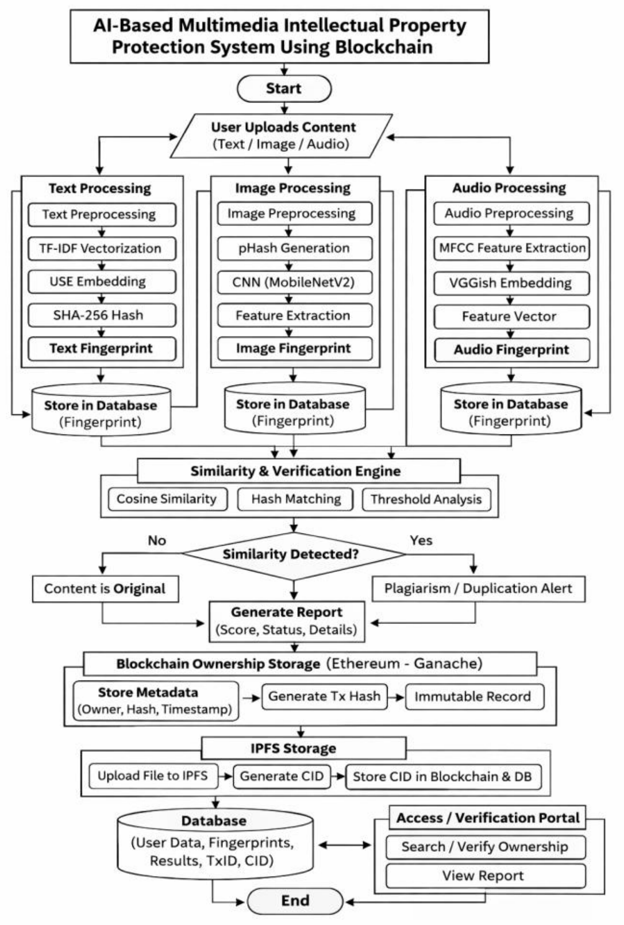

Fig.1. BLOCK DIAGRAM

D. Module Identification and Functional Description

The system architecture follows a modular approach:

1) User Interface Module: For content upload and verification access.
2) AI Fingerprinting Module: Generates unique content representations (CNN features, NLP embeddings, spectral features).
3) Similarity Detection Module: Performs similarity computation and plagiarism analysis.
4) Blockchain Registration Module: Records ownership metadata, hashes, and timestamps via smart contracts.
5) Decentralized Storage Module: Stores digital assets off-chain using IPFS.
6) Monitoring and Alert Module: Tracks infringement and generates real-time notifications.
7) Database and Logging Module: Stores metadata, logs, and fingerprint indices.

E. System Requirements

System requirements define the minimum and recommended configurations required to support Artificial Intelligence processing, blockchain interaction, and decentralized storage.

1) Hardware Requirements

a) Processor: Intel Core i5 or higher for parallel execution of AI inference and blockchain operations
b) Memory: Minimum 8 GB RAM (16 GB recommended) for efficient feature extraction and similarity computation
c) Storage: Minimum 100 GB for datasets, fingerprints, blockchain artifacts, and logs
d) Network: Stable internet connectivity for blockchain and IPFS communication
e) GPU: NVIDIA CUDA-enabled GPU recommended for deep learning–based feature extraction

2) Software Requirements

a) Operating System: Windows, Linux, or macOS

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b) Programming Language: Python 3.9 or higher
c) Frontend: HTML, CSS, JavaScript
d) Backend Framework: Flask
e) AI Libraries: TensorFlow, PyTorch, OpenCV, Librosa, NumPy
f) Blockchain Tools: Ganache, Truffle, Solidity, Web3.py
g) Database: SQLite
h) Decentralized Storage: IPFS
i) Development Tools: Visual Studio Code, Git, Node.js

F. Design Process and Explanation

System design follows **a layered and modular architecture,** separating presentation, processing, verification, and storage layers to ensure flexibility and scalability.

Initially, digital assets submitted through the user interface undergo preprocessing to normalize formats and remove noise. Domain-specific preprocessing pipelines prepare text, image, and audio data for efficient fingerprint extraction.
Artificial Intelligence models generate high-dimensional feature vectors representing unique content identity. Cryptographic hashing secures these fingerprints prior to blockchain registration. Ownership metadata, creator identifiers, and timestamps are recorded through smart contract execution, ensuring immutability and transparency.
Large digital assets are stored using IPFS to reduce blockchain storage overhead while maintaining verifiable content references. Similarity detection mechanisms compare newly generated fingerprints against existing records to identify plagiarism, partial reuse, or format transformation.

Continuous monitoring workflows enable early detection of unauthorized reuse. Alert mechanisms notify content owners in real time, while logging modules maintain audit trails to support dispute resolution and verification history.
Design methodology emphasizes automation, decentralization, security, and extensibility, enabling deployment in academic environments and future real-world applications.

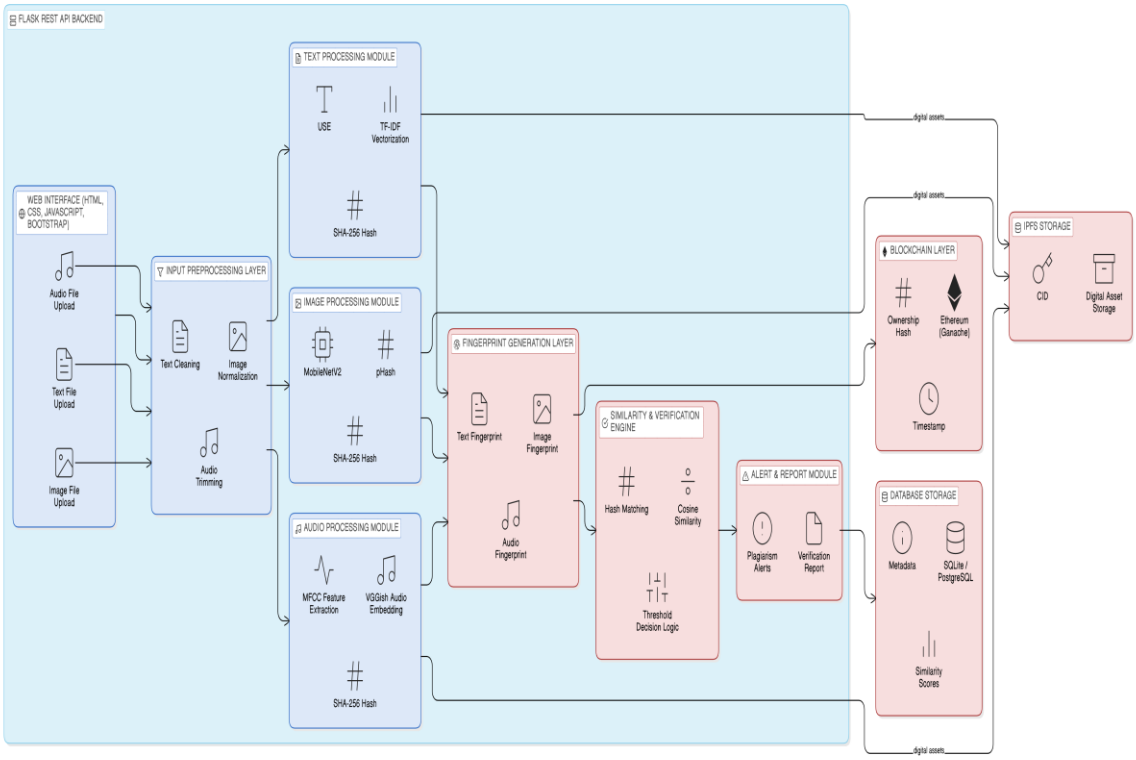

Fig.2. Overall System Architecture of the Proposed Framework

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IV. METHODOLOGY

Describes the complete methodology adopted for the proposed Artificial Intelligence and blockchain-based intellectual property protection framework. The methodology integrates Artificial Intelligence–driven fingerprinting, similarity evaluation, and blockchain-based ownership verification into a unified, automated workflow. The system is designed to support multiple digital content formats while ensuring robustness, scalability, and resistance to tampering.

A. Overview of System Methodology

Proposed methodology follows a modular and sequential processing pipeline that enables secure originality verification and tamper-resistant ownership validation for digital intellectual property. Digital content in the form of text, image, or audio is processed through domain-specific analysis pipelines while sharing a common verification and ownership framework.

Initially, user-submitted content is received through a secure web interface. Preprocessing operations are applied to standardize data formats and eliminate noise. Feature extraction techniques then generate robust fingerprints representing intrinsic content characteristics. These fingerprints are compared against previously registered fingerprints using similarity evaluation algorithms. Based on similarity scores and predefined thresholds, the system classifies content originality and proceeds with ownership verification through blockchain integration.

Methodology emphasizes automation, decentralization, and accuracy, enabling real-time plagiarism detection and continuous monitoring across digital platforms.

B. Content Preprocessing Stage

Preprocessing is a critical stage that ensures consistency and reliability in subsequent fingerprint generation and similarity analysis.

1) Text Preprocessing:

Textual data undergoes normalization, lowercasing, stop-word removal, punctuation elimination, and tokenization. These operations reduce noise and enhance meaningful feature extraction.

2) Image Preprocessing:

Images are resized, normalized, and converted into standardized formats to ensure consistent input dimensions for perceptual hashing and convolutional neural networks.

3) Audio Preprocessing:

Audio signals undergo silence trimming, resampling, amplitude normalization, and noise stabilization to improve robustness against recording variations.

Preprocessing ensures that content transformations do not adversely affect fingerprint stability.

C. Text Analysis and Fingerprinting Methodology

1) Purpose

Text Analysis and Fingerprinting Module focuses on detecting plagiarism, duplication, and paraphrasing by analyzing both lexical similarity and semantic meaning within textual content.

2) Feature Extraction Techniques

- TF-IDF Vectorization:

Term Frequency–Inverse Document Frequency transforms processed text into weighted numerical vectors. Informative terms receive higher weights, enabling detection of partial copying and reused content.

- Semantic Embedding Using Universal Sentence Encoder (USE):

USE converts sentences into dense semantic vectors that preserve contextual meaning. This enables detection of paraphrased content where wording differs but intent remains the same.

3) Cryptographic Hashing

SHA-256 hashing generates a fixed-length cryptographic hash of textual content. Hash matching enables rapid detection of exact duplicates and ensures data integrity during blockchain registration.

4) Similarity Evaluation

Cosine similarity is applied to both TF-IDF vectors and semantic embeddings. Combined similarity scores improve detection accuracy by integrating surface-level and semantic similarity.

5) Outcome

Module classifies text as original, partially plagiarized, or semantically paraphrased with high reliability.

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D. Image Analysis and Fingerprinting Methodology

1) Purpose

Image Analysis and Fingerprinting Module aims to detect visual plagiarism under transformations such as resizing, compression, format conversion, and minor visual modifications.

2) Feature Extraction Techniques

- Perceptual Hashing (pHash):

Perceptual hashing generates visual hashes based on frequency-domain representations rather than raw pixel values. Visually similar images produce similar hash values even after transformations.

- Deep Feature Extraction Using MobileNetV2:

MobileNetV2 extracts high-level visual features representing shapes, textures, and spatial relationships. The lightweight architecture ensures computational efficiency while maintaining discriminative capability.

3) Similarity Evaluation

Hamming distance is used to compare perceptual hashes, while cosine similarity evaluates deep feature vectors. The combination improves robustness against visual alterations.

4) Outcome

Module accurately identifies reused or modified images while remaining resilient to common transformations.

E. Audio Analysis and Fingerprinting Methodology

1) Purpose

Audio Analysis and Fingerprinting Module detects reused, trimmed, or remixed audio content while maintaining resilience against noise, compression, and format variations.

2) Feature Extraction Techniques

- Mel-Frequency Cepstral Coefficients (MFCC):

MFCCs capture spectral characteristics aligned with human auditory perception, representing timbre and pitch-related features.

- Deep Audio Embeddings Using VGGish:

VGGish generates compact deep embeddings trained on large-scale audio datasets, providing robustness against compression, background noise, and temporal variations.

3) Similarity Evaluation

Cosine similarity is applied to deep audio embeddings to determine similarity independent of temporal alignment.

4) Outcome

Module reliably detects duplicated, reused, or modified audio content with high precision.

F. Similarity Evaluation and Decision Engine

Similarity Evaluation and Decision Engine integrates fingerprints generated from text, image, and audio modules to determine the originality status of submitted content.

1) Cosine Similarity

Cosine similarity is used to measure the similarity between two feature vectors by computing the cosine of the angle between them. It evaluates the directional similarity between vectors rather than their magnitude.

The cosine similarity between two vectors A and B is defined as:

Cosine Similarity = {A . B}/{|A| |B|}

where

A . B represents the dot product of the vectors,

|A| is the magnitude of vector A, and

|B| is the magnitude of vector B.

The range of cosine similarity is:

- 1 → Identical vectors
- 0 → Orthogonal (unrelated) vectors
- −1 → Opposite vectors

In the proposed system, similarity values typically lie between 0 and 1 since feature vectors are non-negative.

a) Example Using Image Feature Vectors

After passing an image through MobileNetV2, a high-dimensional feature vector (1280-dimensional) is generated. For demonstration purposes, only the first five values are considered.

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Let the feature vectors be:
A = [0.84,0.31,0.12,0.66,0.50]

B = [0.83,0.32,0.11,0.65,0.49]

b) Dot Product Calculation

A . B = (0.84 x 0.83) + (0.31 x 0.32) + (0.12 x 0.11) + (0.66 x 0.65) + (0.50 x 0.49)

= 0.697 + 0.099 + 0.013 + 0.429 + 0.245

= 1.483

c) Magnitude Computation

|A\ = sqrt{0.84^2 + 0.31^2 + 0.12^2 + 0.66^2 + 0.50^2}
= sqrt{1.49} = 1.22

|B| = sqrt{0.83^2 + 0.32^2 + 0.11^2 + 0.65^2 + 0.49^2}
= sqrt{1.45} = 1.20

d) Final Cosine Similarity Computation

Cosine Similarity= {1.483}/{1.22 x 1.20}
= 0.99

e) Interpretation
The computed similarity value is approximately 0.99, indicating that the two images are nearly identical. According to the predefined threshold criteria in the proposed system:

- Similarity ≥ 0.90 → Duplicate
- 0.70 – 0.89 → Partial Similarity
- < 0.70 → Original

Since the similarity value is 0.99, the images are classified as duplicates.

2) Threshold-Based Classification
Similarity scores are mapped to predefined ranges:

- Low similarity → Original content
- Medium similarity → Partial plagiarism
- High similarity → Full duplication

3) Outcome
Engine produces a definitive originality verdict with high consistency and accuracy.

G. Blockchain-Based Ownership Verification Methodology
1) Purpose
Blockchain integration ensures tamper-resistant ownership validation and eliminates intellectual property disputes through decentralized ledger mechanisms.
2) Ownership Registration Process
Generated content fingerprints are hashed using SHA-256 and submitted to the blockchain along with ownership metadata and timestamps.
3) Smart Contract Execution
Smart contracts automate ownership registration and verification, enforcing predefined rules without manual intervention.
4) Outcome
The module provides immutable, verifiable proof of ownership with transparent audit trails.

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H. IPFS Storage and Database Management Methodology

1) Decentralized Asset Storage

Large multimedia assets are stored off-chain using IPFS to reduce blockchain storage overhead while ensuring content integrity.

2) Metadata Management

Databases store user information, fingerprint indices, similarity scores, blockchain transaction hashes, and IPFS content identifiers.

3) Outcome

Hybrid storage approach ensures scalability, efficiency, and secure metadata management.

I. Alert and Verification Report Generation

System automatically generates verification reports containing similarity scores, originality classification, and ownership confirmation. Real-time alerts notify users upon detection of plagiarism or duplication, enabling timely enforcement and dispute resolution.

V. RESULT ANALYSIS

The result analysis evaluates the performance of the proposed multimedia intellectual property protection system across text, image, audio, blockchain verification, and decentralized storage components. The evaluation focuses on similarity detection accuracy, robustness against content modification, ownership validation reliability, and storage integrity. Experimental observations confirm the effectiveness of AI-driven fingerprinting combined with blockchain-based verification mechanisms.

A. Text Analysis Results

Text analysis demonstrates the capability to detect semantic similarity beyond exact keyword matching. The Universal Sentence Encoder (USE) successfully identifies paraphrased sentences by generating contextual semantic embeddings that capture meaning relationships between textual inputs. TF-IDF vectorization effectively highlights keyword overlap by assigning higher weights to significant terms while reducing the influence of commonly occurring words.

The combined similarity computation integrating semantic embedding similarity and TF-IDF cosine similarity improves detection accuracy and reduces false positives.

The similarity threshold for textual content is defined as:

- $\geq 70\%$ → High similarity detected
- $\geq 40\%$ → Partial similarity
- $\geq 90\%$ → Confirmed infringement

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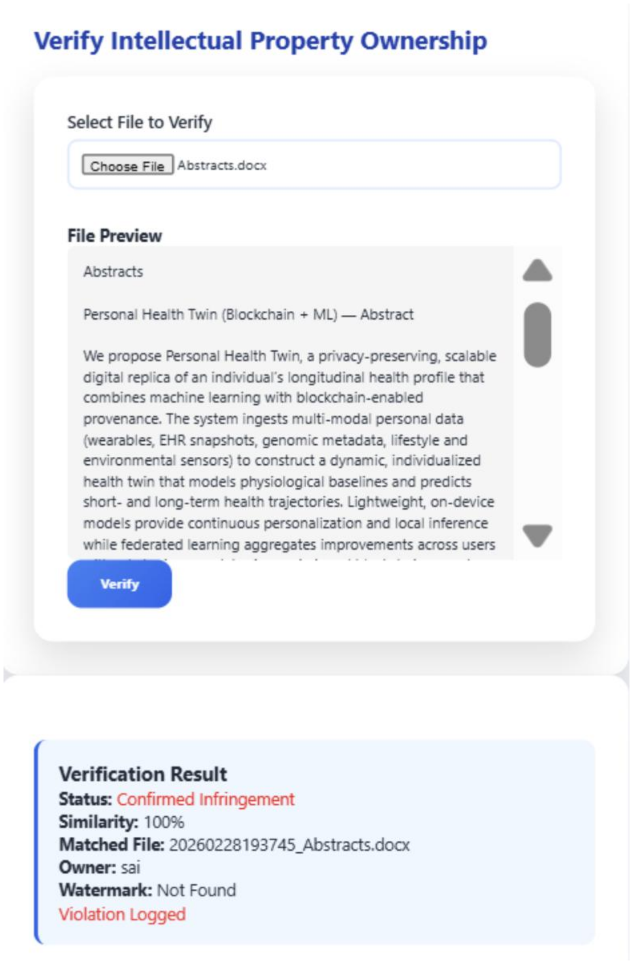

Fig.3.Text Similarity Output

B. Image Analysis Results

Image analysis validates the effectiveness of perceptual hashing and deep convolutional feature extraction techniques. The pHash mechanism detects near-duplicate images by analyzing frequency components rather than raw pixel values, enabling similarity detection even after resizing or compression.

MobileNetV2 extracts high-level visual representations capturing structural and semantic features such as shapes and textures. Robust performance is observed under resizing and compression transformations, confirming resilience against common image modifications.

The similarity threshold for image classification is defined as:

- ≥ 75% → High similarity detected
- ≥ 40% → Partial similarity
- ≥ 90% → Confirmed infringement

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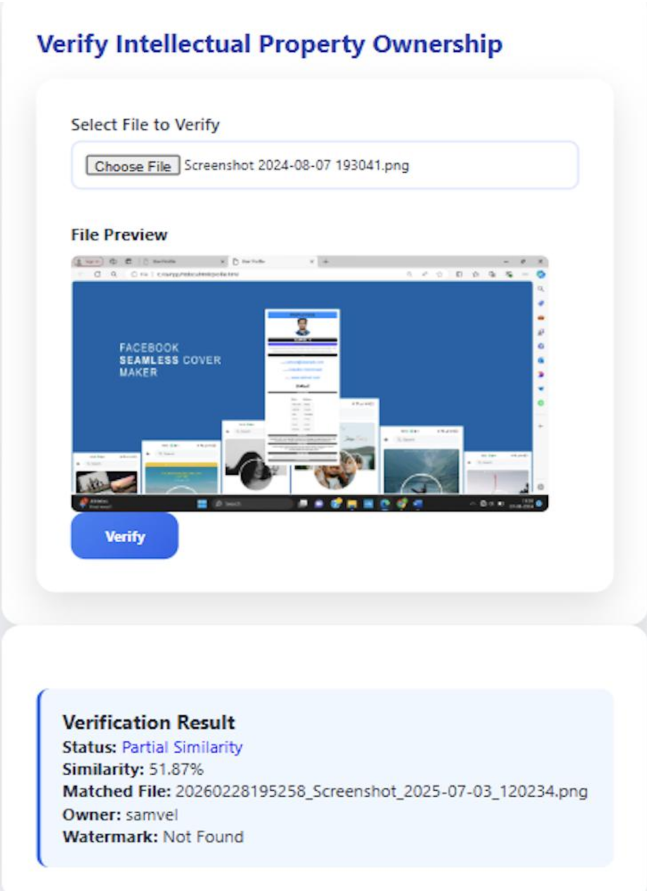

Fig.4.Image Similarity Output

C. Audio Analysis Results

Audio analysis evaluates the system's ability to recognize reused or modified sound recordings. MFCC features effectively capture spectral characteristics aligned with human auditory perception, representing timbre and phonetic patterns.

VGGish embeddings enhance robustness by generating deep audio representations resilient to noise, trimming, and compression. Similarity detection remains stable under frequency-domain transformations.

The similarity threshold for audio content is defined as:

- $\geq 65\% \rightarrow$ High similarity detected
- $\geq 40\% \rightarrow$ Partial similarity
- $\geq 90\% \rightarrow$ Confirmed infringement

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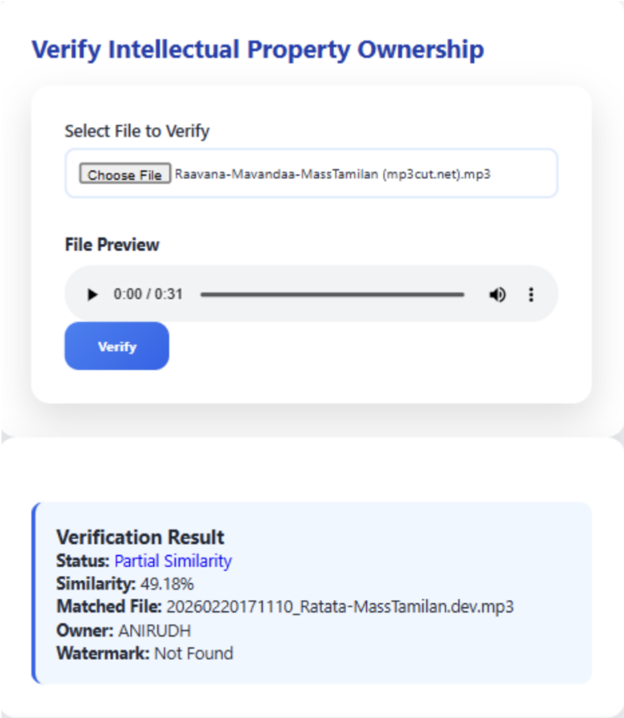
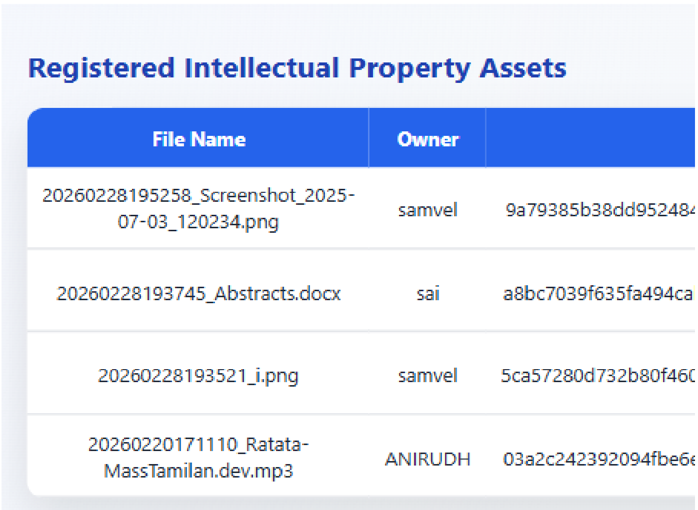


Fig.5.Audio Similarity Output

D. Blockchain Verification Results

Blockchain verification confirms the reliability and immutability of ownership authentication. Once ownership metadata is stored, it remains tamper-resistant after transaction confirmation. Each transaction includes a timestamp establishing chronological priority during disputes.

Ownership disputes are resolved by comparing stored fingerprint hashes with blockchain transaction hashes, enabling transparent and decentralized validation without centralized authority dependency.


Registered Intellectual Property Assets

File Name	Owner	
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20260220171110_Ratata-MassTamilan.dev.mp3	ANIRUDH	03a2c242392094fbe6

Fig.6.Ownership Verification Sample Records

E. IPFS Storage Results

Decentralized storage evaluation confirms integrity preservation through content-addressed storage mechanisms. Identical files consistently generate identical Content Identifiers (CIDs), validating deterministic hashing behavior.

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The decentralized architecture eliminates single-point failures and improves content availability. Retrieval integrity is automatically validated during CID verification.

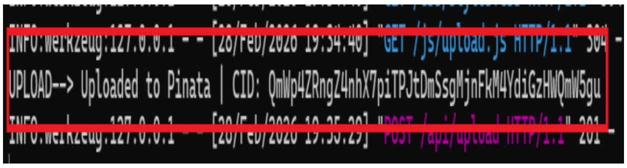

Fig.7.IPFS CID Output Screenshot

VI. DISCUSSION

The integration of AI-based fingerprinting with blockchain infrastructure establishes a multi-layered protection framework combining similarity detection, cryptographic validation, and decentralized storage.

A. Component Contribution Analysis

Table 6.1 summarizes the contribution of each component within the protection framework.

Component	Contribution
AI Models	Semantic and perceptual similarity detection
Hashing	Integrity verification
Blockchain	Ownership immutability and timestamp validation
IPFS	Decentralized multimedia storage
Dashboard	Transparency and verification reporting

Table 6.1 – Component Contribution in Protection Framework

Artificial intelligence models enable multimodal similarity analysis across text, image, and audio domains. Cryptographic hashing ensures content integrity by generating modification-resistant identifiers. Blockchain guarantees immutable ownership registration, while IPFS provides scalable storage without increasing blockchain overhead.

B. Similarity Classification Logic

Similarity classification follows structured evaluation logic:

- ≥ 90% → Confirmed infringement
- ≥ Media-specific threshold (Text: 70%, Image: 75%, Audio: 65%) → High similarity detected
- ≥ 40% → Partial similarity
- < 40% → Original content

This layered classification reduces false positives while maintaining high detection sensitivity.

C. Performance Considerations

Performance analysis reveals a trade-off between deep feature extraction time and similarity accuracy. While higher computational complexity increases detection precision, the lightweight architecture (MobileNetV2 and VGGish) maintains practical deployment feasibility.

Cosine similarity proves effective across heterogeneous feature spaces due to magnitude-independent comparison capability. Blockchain integration removes reliance on centralized trust systems while preserving verifiable ownership history. The decentralized storage architecture enhances scalability and resilience for large multimedia datasets.

VII. CONCLUSION

Proposed Artificial Intelligence and blockchain-based framework provides a robust, decentralized, and automated solution for digital intellectual property protection across text, image, and audio formats. By integrating AI-driven fingerprinting for accurate originality detection with blockchain's immutable ownership verification, the system successfully addresses the limitations of conventional centralized systems, offering transparency, resilience, and scalability.

Future enhancements include the integration of advanced forgery detection techniques, development of automated licensing and royalty distribution mechanisms, mobile application integration for on-the-go verification, and expansion of the cloud-based monitoring service for wider platform coverage.

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