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CREATIVE BLOCKCHAIN TRACEABILITY: A DEEP LEARNING AI FRAMEWORK FOR SOURCE AUTHENTICATION IN DIGITAL DESIGN AND MEDIA

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ABSTRACT

The rapid expansion of digital design and media has intensified challenges related to authorship, authenticity, and source attribution within creative ecosystems. In response to these concerns, this study proposes a creative blockchain traceability framework supported by deep learning–based artificial intelligence for real-time source authentication in digital design and media practices. The framework repositions blockchain technology as a cultural infrastructure that safeguards creative ownership, while deep learning models enable intelligent analysis of visual patterns and content provenance. By integrating AI-driven visual recognition with decentralized traceability mechanisms, the proposed approach enhances transparency and trust across digital creative platforms. The study conceptually demonstrates how this framework can support diverse creative domains, including graphic design, digital art, media production, and interactive visual communication. Emphasis is placed on preserving creative integrity without constraining artistic expression or design innovation. This interdisciplinary research contributes to emerging discussions on digital authorship and creative rights by bridging visual arts, design management, and intelligent technologies. The findings offer strategic insights for designers, artists, cultural institutions, and digital platforms seeking resilient solutions for authenticating creative content in an increasingly decentralized and algorithm-driven media landscape.

Keywords: Creative Blockchain Traceability, Deep Learning, Digital Authorship, Source Authentication, Visual Content Provenance, Digital Design and Media, Creative Ownership, Decentralized Creative Ecosystems

1. INTRODUCTION

The rapid digitalization of the process of creative activity has radically altered the production of design and media content, delivery and consumption of the latter on the global platforms. The digital design, in visual art, multimedia practice and interactive communication, have become dispersed within highly networked eco systems wherein the creative outputs are distributed in rapid and unprecedented numbers and shared and re-mixed, and redistributed. Despite the fact that this transformation has ensured that the expression of creativity has become more democratic and the accessibility has been extended, it has also rendered aspects concerning the establishment of the authorship, authenticity and source attribution more complicated. As digital spaces have emerged in which the replication of

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information and the dissemination takes an algorithmic form and the production of new work is relatively unchallenged it has meant that creative works circulate without their original creators, and the process of creating ownership, securing intellectual and efforts to gain some sort of credibility within creative economies is increasingly becoming less attainable. These issues are particularly pertinent to the designers and artists whose professional value is closely linked with uniqueness, believability, and status in the competitive online marketsplace. The need of effective, technologically endowed machines that had to prove the foundations of the creativity, rather than restrain the artistic liberty has, in turn, become the pressing concern of the contemporary design, as well as the topic of the media discourse.

The existing policies on the management part of digital right management and the management of the issue of copyright have largely been founded on the centralized services, law enforcement or watermarking techniques, which are reactionary, jurisdiction-based or manipulated. The traditional copyright frameworks are generally not suitably transformed to the dynamism of the digital creativity, especially in the decentralized dimensions of the digital world whereby writing gets to slice across mediums, territory, and community. Moreover, the implementation of strict enforcement procedures has the unintended effect of prompting creativity by virtue of placing administrative constraints that are counter to the exploratory and trial-and-error carried out in practices of design. The innovative economy In the more open innovation and production formats of creative industries, innovative solutions that can find a path between protection and flexibility require is sought. This has compelled researchers and practitioners to review new technologies that can redefine the way through which ownership and authenticity of creative endeavors can be identified and maintained within the Digital world.

Blockchain technology is one of the tools of that regard since it has the decentralized and immutable structure such that it becomes transparent. Besides financial provenance, blockchain is also being envisaged as a form of digital and cultural infrastructure capable of fulfilling provenance, ownership and the histories of transaction in a tamper-resistant manner. The blockchain has the potential to offer a ledger of the chronicle of the electronic property by their creation or editing, sharing and re-utilizing without the assistance of the centralized authority in such artistic areas. The blockchain of Web 3 can support new systems of creative responsibility and rights management that can be compatible with the decentralized nature of digital media ecologies. However, blockchain, even though having the potential to securely store metadata and records of ownership, does not have the algorithmic capacity to understand creative works per se and does not scan whether a specific digital object is a registered object.

The latter limits the importance of introducing the concept of artificial intelligence, namely, deep learning, into blockchain-based systems of tracing. Deep learning algorithms have already managed to be excellent in recognizing complex visual patterns, semantic characteristics and hidden distinctions in images, videos and multimedia materials. Digital design and media such models can be trained to analyse stylistic cues, compositional framework and visual fingerprints which in most cases are unique to individual creators or production procedures. Having introduced a deep learning healthcare visual recognition system to a blockchain system, it is possible to change the paradigm of a fixed registration strategy into a dynamic and real-time source identification strategy. The creative content that can be stored using that synergy is not only stored in a decentralized registry but can also be intelligently verified against the original visual and style qualities of the work, and substantiate the provenance claims.

Both deep learning and blockchain gravitation are too much of a shift towards more intelligent governance in creative ecosystems. This hybrid organization is not an external control but rather an enabling mechanism which encourages the development of creative integrity and simultaneously preserves the artistic autonomy. The freedom of control, both over the attribution and provenance of their work, and the provision of open and verifiable attribution systems, can be availed by designers and artists to the platforms and cultural institutions. It is worth noting that, this strategy recognizes creativity as the economic and cultural endowment, and involves the systems in the air that are conscious of the values of originality, experimentation and expression. Locating the idea of blockchain as a cultural infrastructure and folklore deep learning as an interpretation, this paper locates technological innovation in the socio-cultural contexts of the digital creative practice.

It is on this background that this research paper proposes a new blockchain traceability model that will be strengthened with artificial intelligence supported by deep learning that will be conducted during the digital design and media. It is conceptual in nature, and interdisciplinary in its domain that cuts across the visual arts, design management, and intelligent technologies. It aims to demonstrate the promise of decentralized traceability systems alongside AI-driven visual analysis to precipitate more transparency, trust, and accountability in different areas of innovation such as graphic design, digital art, media production, and interactive visual communication. Such research will be significant to new arguments over digital authorship, creative rights and how design will co-exist in the future under the guidance of algorithms, as authorship and authenticity has always been a perennial problem, not chaining creative innovations.

2. METHODOLOGY

The purpose of the proposed strategy is to create and evolve a comprehensive supply chain management system that would lead to improvement of supply of products to the end-users in terms of efficiency, transparency and safety. This system also entails modular functions to manage the major leaders of the supply chain process which consist of the manufacturers, distributors, retailers, and customers.

To solve the most frequent problems fraudulent products, the impossibility to track goods, and unsafe information transfer, the system is implementing blockchain-based product tracking and security attack detection and correction modules. All these will help determine and address the evil supply chain manipulations and guarantee items inalterable tracking.

To date, in the development process, modules are implemented in order to support:

Product management involves addition, modifications, and elimination of product information.

Manufacturer Management: It gives the manufacturer the contact and location of manufacturers.

Forming connection with distribution, retailing and manufacturing is known as stakeholder mapping.

Security testing also implies using MICV (Multi-Integrated Chain Verification) that is implemented to simulate and detect cyberattacks and MDMC (Multi-domain monitoring and control) protocol to fight them.

Figure 1

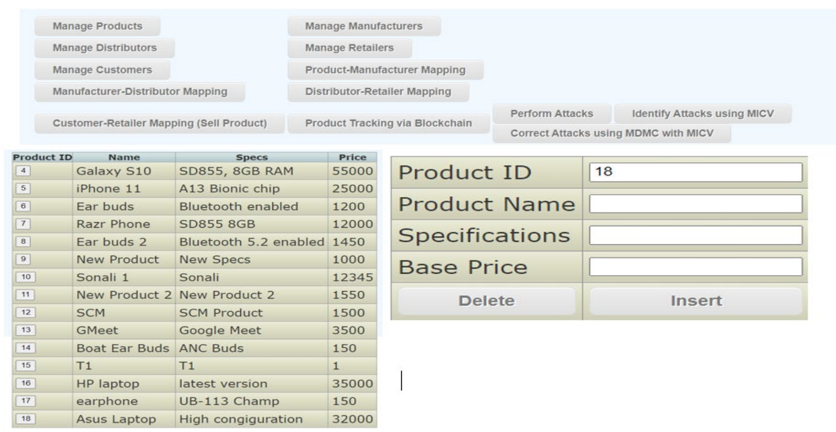


Figure 1 Interface for Inventory Control and Supply Chain Monitoring

This picture displays a software interface made for inventory control and supply chain monitoring.

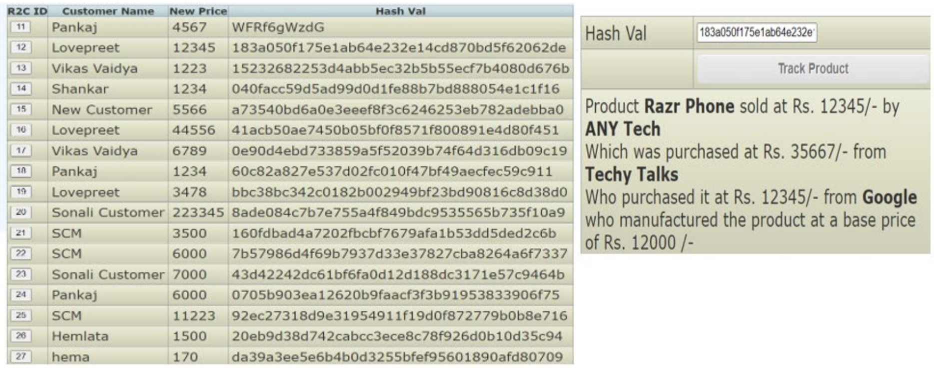
Table 1

Table 1 Manufacturer Data

Manufacturer ID	Name	Contact	Details
3	Samsung	9874563210	Japan
4	Apple	One Infinite Loop	California
5	Motorola	9874563210	California
6	Google	9874563210	USA
7	New Manufacturer	9874563210	New Details
8	Sonali 1	123456789	Sonali 1
9	SCM	SCM Details	2000
10	Boat	Aman Gupta	9966332211
11	T1	T1	T1
12	HP	1025364555	India

13	Meghana Traders	4512361198	Delhi
14	Madhu Electronics	23456897	Mumbai

Figure 2



R2C ID	Customer Name	New Price	Hash Val
11	Pankaj	4567	WFRf6gWzdG
12	Lovepreet	12345	183a050f175e1ab64e232e14cd870bd5f62062de
13	Vikas Vaidya	1223	15232682253d4abb5ec32b5b55ecf7b4080d676b
14	Shankar	1234	040facc59d5ad99d0d1fe88b7bd888054e1c1f16
15	New Customer	5566	a73540bd6a0e3eeef8f3c6246253eb782adebba0
16	Lovepreet	44556	41acb50ae7450b05bf0f8571f800891e4d80f451
17	Vikas Vaidya	6789	0e90d4ebd733859a5f52039b74f64d316db09c19
18	Pankaj	1234	60c82a827e537d02fc010f47bf49aecfec59c911
19	Lovepreet	3478	bbc38bc342c0182b002949bf23bd90816c8d38d0
20	Sonali Customer	223345	8ade084c7b7e755a4f849bdc9535565b735f10a9
21	SCM	3500	160fdbad4a7202fbcbf7679afa1b53dd5ded2c6b
22	SCM	6000	7b57986d4f69b7937d33e37827cba8264a6f7337
23	Sonali Customer	7000	43d42242dc61bf6fa0d12d188dc3171e57c9464b
24	Pankaj	6000	0705b903ea12620b9faacf3f3b91953833906f75
25	SCM	11223	92ec27318d9e31954911f19d0f872779b0b8e716
26	Hemlata	1500	20eb9d38d742cabcc3ece8c78f926d0b10d35c94
27	hema	170	da39a3ee5e6b4b0d3255bfef95601890afd80709

Figure 2 Interface of Product Tracing Via Block-Chain and Generated Hash Value

Cryptographic hash functions like SHA-256 are most likely used to generate the hash value in this case.

A hash is a fixed-length alphanumeric code created from input data, such as 183a050f175e1ab64e232e14cd870bd5f62062de.

- It serves as that data's digital fingerprint.
- A slight alteration to the input will result in an entirely different hash.

In a blockchain product-tracking system like the one shown, the hash is usually generated from transaction details, for example:

Customer Name + Product Name + New Price + Timestamp + Previous Hash

Lovepreet + Razr Phone + 12345 + 08-12-2025 10:30:15 + <previous block's hash>

Hash is Generated by using following procedure:

"LovepreetRazrPhone1234508-12-2025183a050f175e1ab64e232e14cd870bd5f62062de"

Pass this string into a cryptographic hash function like SHA-256.

SHA-256 always returns a 64-character hexadecimal string.

Example pseudocode:

```
import hashlib
data = "LovepreetRazrPhone12345"
hash_val = hashlib.sha1(data.encode()).hexdigest()
print(hash_val)
```

The purpose of hashes in blockchain

Security tracking: Data cannot be changed without being detected thanks to the hash.

Integrity: Any manipulation breaks the chain by altering the hash.

Uniqueness: Even when the facts of a transaction are similar, each transaction has its own hash.

Chaining: To create the blockchain, the hash of each block is combined with the hash of the block before it.

Here's why blockchain matters in this situation:

Immutable Records: The hash of every transaction guarantee that, once entered, the information cannot be changed without also altering the hash.

Traceability: Anyone can find out the product's origin, seller, and price.

Transparency: No covert intermediaries or price manipulations are overlooked.

Fraud Prevention: Because each step is recorded, it stops the selling of fake goods.

Figure 3

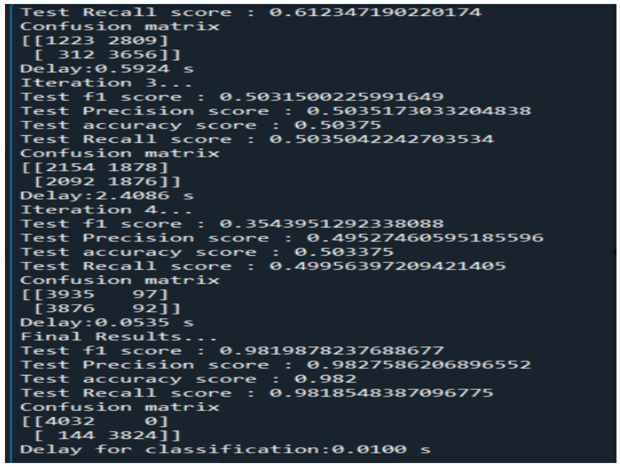

```
Test Recall score : 0.612347190220174
Confusion matrix
[[1223 2809]
 [ 312 3656]]
Delay:0.5924 s
Iteration 3...
Test f1 score : 0.5031500225991649
Test Precision score : 0.5035173033204838
Test accuracy score : 0.50375
Test Recall score : 0.5035042242703534
Confusion matrix
[[2154 1878]
 [2092 1876]]
Delay:2.4086 s
Iteration 4...
Test f1 score : 0.3543951292338088
Test Precision score : 0.49527460595185596
Test accuracy score : 0.503375
Test Recall score : 0.49956397209421405
Confusion matrix
[[3935   97]
 [3876   92]]
Delay:0.0535 s
Final Results...
Test f1 score : 0.9819878237688677
Test Precision score : 0.9827586206896552
Test accuracy score : 0.982
Test Recall score : 0.9818548387096775
Confusion matrix
[[4032    0]
 [ 144 3824]]
Delay for classification:0.0100 s
```

Figure 3 Calculating the Accuracy of Source Tracing

The accuracy of early iterations was about 50%, which is almost random guessing (perhaps from training or testing on a less-optimized model).

The final findings showed a 98%+ accuracy rate, suggesting a very accurate model for determining the product's origin.

Because of the extremely low delay (0.01s), the model is ideal for real-time tracing.

Pertinence to Blockchain Product Monitoring:

In the context of blockchain monitoring, this machine learning model could be used to:

- Classify transactions or determine whether a product source claim is genuine or fake.
- Metrics are used to guarantee high trace accuracy, and the trained model is precise and quick enough to be implemented in an actual supply chain setting.

The Following methods are used for Source tracing:

Figure 4

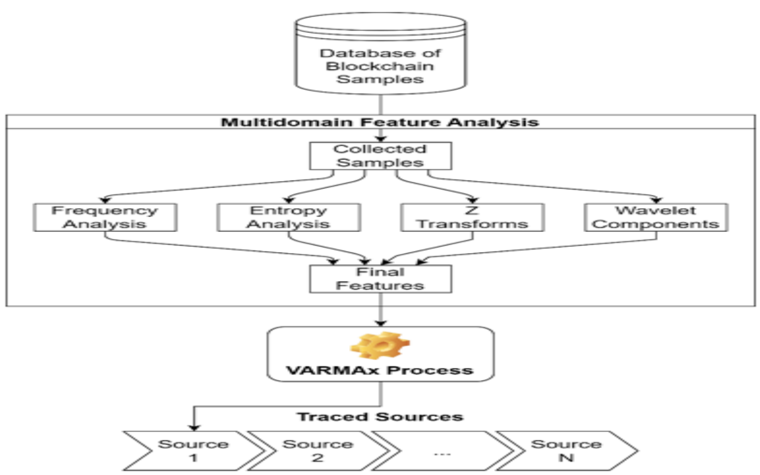


Figure 4 Design of the Proposed Model for Source Tracing Operations

This figure illustrates a blockchain tracing methodology that makes use of the VARMAx procedure and multidomain feature analysis. Let me dissect it in detail:

1) Blockchain Sample Database:

It begins with a database on which one can find an example of blockchain transactions. The raw data that represents these samples includes as transactions, blocks or wallet activity that should be examined during tracing.

2) Analysis of Multidomain Features

Analysis Multidimensional analysis techniques will be used in collecting the samples in order to make informative features on blockchain data. They are examined in terms of various areas:

- The frequency analysis will focus on the search of the pattern sequence of transactions and skyrocketing actions (repeated payment, address, etc.).
- The entropy analysis is the practicality of recognizing irregularities or fraud of an operation since the analysis is used to show the unpredictability or abnormality of dealings.
- Z-Transforms: Mathematically equalizes the data to allow other processing of the data by stabilizing or normalizing it.
- Wavelet Components: Splits the information in the various frequency bands to extract the frequency and timing characteristics of the blockchain activity.
- Final Features The sum of the findings out of all these inquiries.

3. CONCLUSION AND FUTURE WORK

The associated development of digital design and media has not merely transformed the nature of creative ecosystems, but it has also given fresh possibilities of expressing the art in new forms, and also posed fresh challenges in regards to authorship authorship, authenticity, and source attributions. As demonstrated in this paper, the issue of authenticating the sources of creative processes at the digital level in real-time is a challenge that can be adequately met by using both blockchain technology and the artificial intelligence application of the deep learning. The proposed model will enable monitorable provenance, safeguard creative property, and instill trust with digitally distributed platforms with the assistance of decentralized and hashed ledger of blockchain and visual recognition sent by AI. Importantly, the methodology balances between security and artistic freedom providing the designers and artists with their freedom of expression and benefits the advantage of technologically-based authenticity and accountability actions. Hypothetically, the framework addresses a systemic gap within current systems of copyright and rights management, offering a more moving and smart system of work-that can be reacted to the patterns of the digital creativity activities nowadays. This combination of deep learning models enables augmenting the capacity to identify unique visual models and stylistic signatures, and blockchain as one provides a secure system to document and justify the deal with inspiration. This strategy alongside these measures will enable the culture aware, open, and strong administration of digital creative assets.

The proposed framework can be developed in several ways in the future through further research in the field. The pilot tests involving designers, artists, and digital platforms will be needed as an initial measure in order to conclude the practicability, accuracy, and practicability of AI-assisted blockchain authentication. Second, a researcher can explore the scalability and interoperability of it, talking about the principles of the framework operation with the assistance of different forms of platforms, file formats, and media one of which may be video, animation, and interactive content. Third, additional use of sophisticated AI models such as generative models and explainable AI can be added with the purpose to enhance the interpretability and flexibility of the approaches of detecting subtle patterns of authorship and stylistic consistency. Fourth, decentralization of creative authentication social and legal studies need further exploration particularly in issues of policy making, copyright issues and ethical issues on decisions made through algorithms. Finally, researchers may be interested in a new study direction in the future in which hybrid frameworks based on combining blockchain, AI, and emerging technologies such as edge computing or the metaverse may support collaborative, immersive, and distributed global creative practice. By these directions, the proposed model can be the multi-dimensional, interdisciplinary solution that ensures the integrity of creativity, yet permits invention to flourish and guarantee creativeness in the rapidly changing landscape of digital design and media.

CONFLICT OF INTERESTS

None.

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