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A Survey of Blockchain for Video Integrity †

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Abstract: Blockchain has become an important alternative in plenty of industries due to its features such as traceability, transparency and data integrity. Blockchain is not only present in the management of structured data-like names, timestamps, addresses and so on, but also in the management of unstructured data such as videos or images. In the present work, we focus on videos because nowadays, they are potentially exposed to be modified or altered from plenty of sources and platforms. However, we found that there are hardly any surveys or systematic literature reviews containing applications of both blockchain and integrity of videos. Thus, in this survey, we state a literature review for primary articles about the use of blockchain for video integrity to update and provide a better comprehension about this topic. As results, we encountered Ethereum and internet of vehicles as the largest underlying blockchain and field of application, respectively. At the end, we explain our findings about blockchains for video integrity and why it is an emerging topic.

Keywords: blockchain; distributed ledger; video integrity; data integrity; survey

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1. Introduction

Blockchain, the technology behind Bitcoin, the first cryptocurrency in history, has become disruptive in many sectors like supply chains, healthcare, the IoT, privacy and data management [1]. To understand blockchains, we have to backtrack to 2008, when Satoshi Nakamoto, the pseudonym of a person or a group of people, published a paper called "Bitcoin: A Peer-to-Peer Electronic Cash System" [2] in which not only were the basics of Bitcoin defined, but also the underlying technology, blockchain. In simple words, we can define blockchain as a set of blocks linked by hash functions to allow for the storage of transactions [3]. The features of blockchain include decentralization [3–5], integrity verification [1,3–5], immutability [4,5], transparency [1,3–5], and auditability [1,4], among others.

Blockchain is not only present in the management of structured data like names, timestamps, addresses, and so on, but it is also present in the management of unstructured data such as videos or images and, especially, in the feature of integrity verification [1]. The main interest in this matter is because video files have a lot of potential to be tampered with or altered with malicious intentions using certain techniques, e.g., when using AI-enable software for swapping faces in a realistic way on images and videos [6]. In that sense, a Scopus-level literature review was performed, but there were hardly any surveys related to the topic of video integrity, only [6], a survey of deepfake detection, in which a study from the literature proposes a framework to track suspected video's origin directly to their provenance.

Therefore, this survey study can be useful for future research into the use of blockchain for video integrity, since it collects valuable information regarding the most-used blockchains along with their usefulness from previous primary works, which was previously not found

in similar survey studies. The structure of our survey is as follows: In Section 2, we present the methodology of the literature review. In Section 3, we show our results about the literature review we carried out. Finally, in Section 4, we discuss the results, and in Section 5, we detail our conclusions regarding the work.

2. Materials and Methods

In order to query the literature for reviews on the use of blockchains for video integrity, we used the following keyword search string in the Scopus citation database:

TITLE-ABS-KEY ((blockchain OR "distributed ledger") AND ("video integrity" OR video*) AND ("data integrity" OR integrity) AND (survey OR review OR "research synthesis" OR "research integration" OR "systematic overview" OR "integrative research" OR "systematic research synthesis" OR "systematic literature review")). Only one survey from 2022 was found [6], but it is not focused on video integrity. In that sense, we defined our research question for this study:

> RQ: What progress has been made in the area of blockchain regarding the integrity of video files?

Hence, we chose the main words as: blockchain, video and integrity, doing a systematic search in the Scopus citation database, with the following search string:

TITLE-ABS-KEY ((blockchain OR "distributed ledger") AND ("video integrity" OR video*) AND ("data integrity" OR integrity)) AND (LIMIT-TO (OA, "all")) AND (LIMIT-TO (SUBJAREA, "COMP")) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018)) AND (LIMIT-TO (LANGUAGE, "English")).

The search resulted in 22 primary studies and one literature review between years of 2018 and 2023. However, for the purposes of this survey, 13 papers were selected following a selection criteria for a literature review similar to the one from [7], but emphasizing our topic of blockchain for video integrity.

3. Results

In this section, the answer to the proposed research question in Section 2 is given. Since 13 papers were selected, we classified them by study fields and underlying blockchain, as is shown in Table 1. We can see that the three main fields are the internet of vehicles (IoV), video surveillance and criminalistics, having three papers each. Furthermore, other fields like government or copyright are considered in the row "Others".

In Table 1, the works which have been applied to the internet of vehicles field tend to use blockchains for the integrity of videos, to prevent car accidents [8–10]. In the field of video surveillance, internet of things resources like the Raspberry Pi are used with integrated video cameras, so that videos are recorded and sent to a blockchain platform [11–13]. Then, criminalistics is another field in which blockchain for video integrity is used, due to the prevention of video tampering for the presentation of evidence [14–16].

On the other hand, Hyperledger Fabric is the most widely used underlying blockchain, and the internet of vehicles is the field in which it is most widely applied [8,10]. Furthermore, we found that Ethereum is compatible with a variety of application fields such as IoV [9], government [17], copyright [18] and telecommunications [20]. These study fields are covered with Ethereum due not only to its popularity, but also to the amount of free resources that this underlying blockchain offers. Furthermore, refs. [11,13] use a lightweight blockchain, which is a type of blockchain that is compatible with IoT solutions. Finally, we encountered Quantum Chain [14] and Klaytn [16], a private blockchain and a public blockchain, respectively.

Table 1. Use of Blockchain to preserve the integrity of videos.

Study Field	Underlying Blockchain	Description	Publishing Information
Internet of Vehicles	Hyperledger Fabric	On-chain and off-chain architecture for video storage.	Jeong et al. (2018) [8]
	Ethereum	A video sharing scheme with accident detection using deep learning, cloud and blockchain storage.	Kim et al. (2020) [9]
	Hyperledger Fabric	A multi-signature-based access control method for video dashcam sharing with Hyperledger blockchain and Hadoop.	Na and Park (2022) [10]
Video Surveillance	Lightweight Blockchain	A lightweight Blockchain with a privacy protection scheme for surveillance cameras at the edge.	Fitwi et al. (2019) [13]
	Hyperledger Fabric	A blockchain-based system to guarantee the trustworthiness of the stored recordings of CCTVs.	Khan et al. (2020) [12]
	Lightweight Blockchain	A lightweight blockchain to establish data integrity for surveillance cameras using IPFS and Raspberry Pi.	Michelin (2020) [11]
Criminalistics	Quorum Chain	A mobile app called E-Witness that allows recording of videos as evidence, computes a hash of them and sends these to the blockchain.	Samanta and Jain (2018) [14]
	Hyperledger	It is a blockchain-based system that verifies the authenticity of a video recorded by an IoT device through a hash frame comparison.	Danko et al. (2019) [15]
	Klaytn	A blockchain-based system that records a transformation history of an original video.	Lee and Choi (2022) [16]
Others	Ethereum	Temporal content hashes of videos generated from a deep neural network. These hashes are stored then on an Ethereum blockchain.	Bui et al. (2019) [17]
	Ethereum	A blockchain-based platform for copyright agreements of multimedia data.	Liu et al. (2021) [18]
	Hyperledger Fabric	Copyright protection system with double watermarking for videos based on the blockchain.	Zheng et al. (2021) [19]
	Ethereum	It is a video transmission system incorporating blockchain in mobile edge computing (MEC) to preserve the integrity of videos.	Li and Wan (2021) [20]

This table summarizes our findings in the 13 papers mapped within the research that are directly linked to the use of blockchain to preserve the integrity of videos. Three main study fields were found (internet of vehicles, video surveillance, and criminalistics). The underlying blockchain was also mapped per paper, as shown in the "Underlying Blockchain" column, and a short description of the paper in the "Description" column.

As seen in Table 2, nine of the thirteen works show metrics and results related with accuracy [8,9,17], processing time [11,15] and transactions per second [18,19], among others. The works that have metrics of accuracy use blockchains combined with deep learning techniques to give a solution against tampering or forgery of videos, and the one which has an outstanding result is Lee and Choi [16], obtaining an accuracy of 1 in integrity analysis of videos.

Table 2. Use of Blockchain to preserve the integrity of videos.

Underlying Blockchain	Metrics	Results	Paper	Underlying Blockchain	Metrics	Results	Paper
Quorum Chain	-	-	Samanta et al. (2018) [14]	Lightweight Blockchain	Average processing time	0.5 ms/camera	Michelin et al. (2020) [11]
Ethereum	Accuracy for tampering detection	0.981	Bui et al. (2019) [17]	Ethereum	Quality of experience	7	Li and Wan (2021) [20]
Hyperledger	Hashing process	20 ms/frame	Danko et al. (2019) [15]	Ethereum	Transactions per second	60 tps	Liu et al. (2021) [18]
Lightweight blockchain	-	-	Fitwi et al. (2019) [13]	Hyperledger Fabric	Transactions per second	221 tps	Zheng et al. (2021) [19]
Hyperledger Fabric	-	-	Jeong et al. (2020) [8]	Klaytn	Accuracy of Integrity analysis	1.00	Lee and Choi (2022) [16]
Hyperledger Fabric	-	-	Khan et al. (2020) [12]	Hyperledger Fabric	Latency	2 s	Na and Park (2022) [10]
Ethereum	Accuracy of image detection	0.86	Kim et al. (2020) [9]				

This table summarizes the metrics and the results of the thirteen papers described also in Table 1. Milliseconds per frame ("ms/frames") [15] means the time in which a video frame is hashed. Milliseconds per camera ("ms/cameras") [11] means the time to create a video metadata transaction per camera. Transactions per second ("tps") [18] means the average throughput for the "multimedia registration" smart contract, as in [19].

4. Discussion

It is clear that we have two main blockchains (Ethereum and Hyperledger Fabric) we could use to give a solution to preserve the integrity of videos in almost the same fields. Whereas the first is a public blockchain, the second one is a permissioned blockchain, which means that it can only be accessed by users with credentials.

Of all the findings summarized in Table 2, the most surprising is the paper by Lee and Choi, which uses as a metric the ratio of videos identified as modified over the total number of videos, in which it is shown that their method gives a result of 1, meaning that it identifies modified videos in their entirety.

5. Conclusions

In this work, we have applied a literature review to find articles related to the use of blockchains to preserve the integrity of videos, which is a relevant topic because nowadays, video files could be easily faked or tampered with with malicious intentions. The search was carried out in Scopus and, following a selection criteria, a total of 13 primary articles from 2018 to 2022 were analyzed to answer the research question proposed. From the results, the internet of vehicles, video surveillance and criminalistics are the three main topics in which blockchains are applied for video integrity. Moreover, Ethereum and Hyperledger Fabric are the main underlying blockchains used, due to the fact that these are more mature technologies, having a variety of free support and resources. In summary, nine of the thirteen papers selected were published from 2020 onward, which shows that the topic of blockchain for video integrity is emerging, though further investigation is necessary.

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