Current Ophthalmology

Under lock and key: Incorporation of blockchain technology in the field of ophthalmic artificial intelligence for big data management - A perfect match?

Prasanna Venkatesh Ramesh, Aji Kunnath Devadas[1], Prajnya Ray[1], Shruthy Vaishali Ramesh[2], Tensingh Joshua[3], Vinoth Priyan[4], Meena Kumari Ramesh[5], Ramesh Rajasekaran[6]

Big data has been a game changer of machine learning. But, big data is a form of centralized version of data only available and accessible to the technology giants. A way to decentralize this data and make machine learning accessible to the smaller organizations is via the blockchain technology. This peer-to-peer network creates a common database accessible to those in the network. Furthermore, blockchain helps in securing the digital data and prevents data tampering due to human interactions. This technology keeps a constant track of the document in terms of creation, editing, etc., and makes this information accessible to all. It is a chain of data being distributed across many computers, with a database containing details about each transaction. This record helps in data security and prevents data modification. This technology also helps create big data from multiple sources of small data paving way for creating a well serving artificial intelligence model. Here in this manuscript, we discuss about the usage of blockchain, its current role in machine learning and challenges faced by it.

Key words: Blockchain, Artificial Intelligence, Big Data Management, Cryptocurrency, Permissionless Blockchain Network, Permissioned Blockchain

By studying technological innovations, one thing is very evident: if there is to be a blockchain revolution, many barriers, including technological, governance, organizational, and even societal barriers should fall. As it happened with e-commerce and online travel agencies, many common activities can face drastic innovative changes, thanks to the technology that introduces a new notion of decentralized validation of processes, ownership, and trading. In this manuscript, we have proposed one such technology called the blockchain technology on (big) data management for collection, validation, access control, and elaboration in the field of ophthalmic artificial intelligence (AI). It is one of the technologies of the 4th industrial revolution.

The ophthalmology health care sector currently faces a pressing need for new digital technologies that allow secure and efficient data sharing for AI management and big data analytics.[1] Blockchain technology promises to deliver novel digital platforms that can address the inefficiencies and demands of the current ophthalmic AI systems. In the field of ophthalmology, blockchain technology can help monitor data and the integrity of the results in AI.

Invented in 2008 by Satoshi Nakamoto, blockchain is a decentralized ledger with immutable properties allowing secure verifiable transfer of data in a peer-to-peer fashion by utilizing a common consensus protocol to prevent single points of failure. Though a variety of use cases have been developed to harness the advantages of blockchain technology, largely in the financial sector and the business world; it is particularly relevant in the management of big data and AI research, notably in the field of ophthalmology due to its abundance of numerical data and imagery.[2-4]

Role of Blockchain Technology in Ophthalmic AI

Ophthalmic AI is a growing branch with active research.[5,6] It is highly reliant on the availability of large, high-quality datasets with rigorous model validations and multiple testing phases.[7-9] However, the management of diverse data from different countries and centres for training and testing of algorithms poses significant challenges, such as data security threats and patient confidentiality issues. These challenges may prevent the honest transfer of research medical data to support collaborative efforts.[10] In addition, due to a lack of transparency regarding model validation and testing, proper

Medical Officer, Department of Glaucoma and Research, [1]Consultant Optometrist, Department of Optometry and Visual Science, [2]Medical Officer, Department of Cataract and Refractive Surgery, [3]Head of the Department, Mahathma Centre of Moving Images, [4]iOS Engineer, Mahathma Centre of Moving Images, [5]Head of the Department of Cataract and Refractive Surgery, [6]Chief Medical Officer, Mahathma Eye Hospital Private Limited, Trichy, Tamil Nadu, India

Correspondence to: Dr. Prasanna Venkatesh Ramesh, Mahathma Eye Hospital Private Limited, No. 6, Seshapuram, Tennur, Trichy - 620 017, Tamil Nadu, India. E-mail: email2prajann@gmail.com
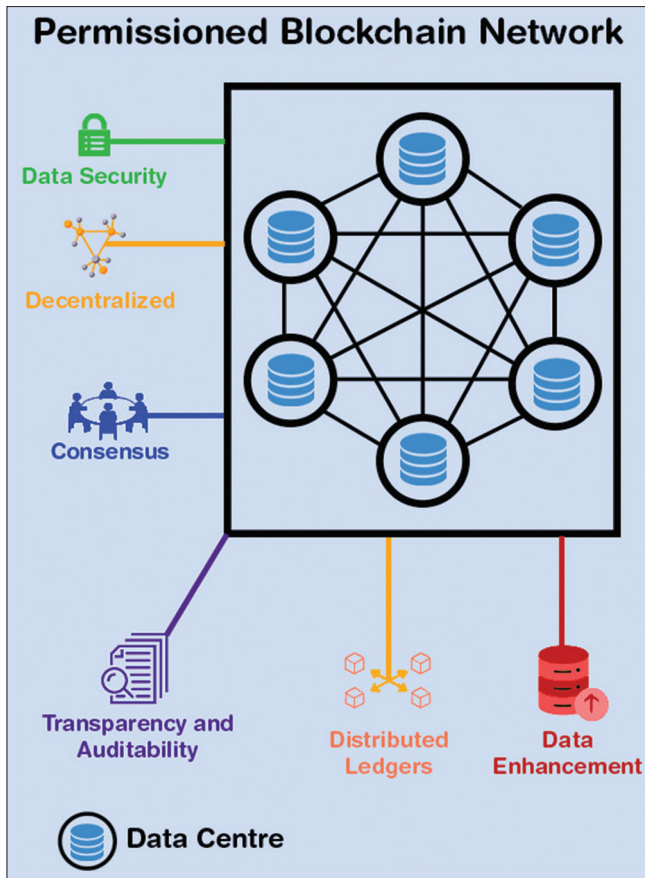
Figure 1: Image showing permissioned blockchain network among multiple data centres which benefit from various features

Figure 2: Image showing permissionless blockchain network among multiple data centres

research surveillance over the novel AI systems is unattainable. Hence, we have proposed the permissioned blockchain-enabled platform to assist the AI algorithms.

The advantages of this technology are multifolds and are as follows:
- Designs a software architecture for decentralized data storage for what concerns the administration of data (validity, privacy, access control, and incentivization to participation)
- Implements an advanced prototype for medical data sharing technology readiness level (TRL)
- Creates distributed datasets and priorities medical use cases for important social and scientific impacts
- Creates tools and platforms for the emergence of a community of students, entrepreneurs and managers of small and medium-sized enterprises, academic researchers in different fields, and other experts aimed at recognizing the importance of distributed ownership and control of data and getting acquainted with the use of blockchain technology.

Blockchain Technology - Relevance in Developing Countries

Blockchain technology is an evolving area, and its acceptance in healthcare is completely dependent on the availability of quality information of both operational and clinical data. In developing countries like India, there is only a minor percentage
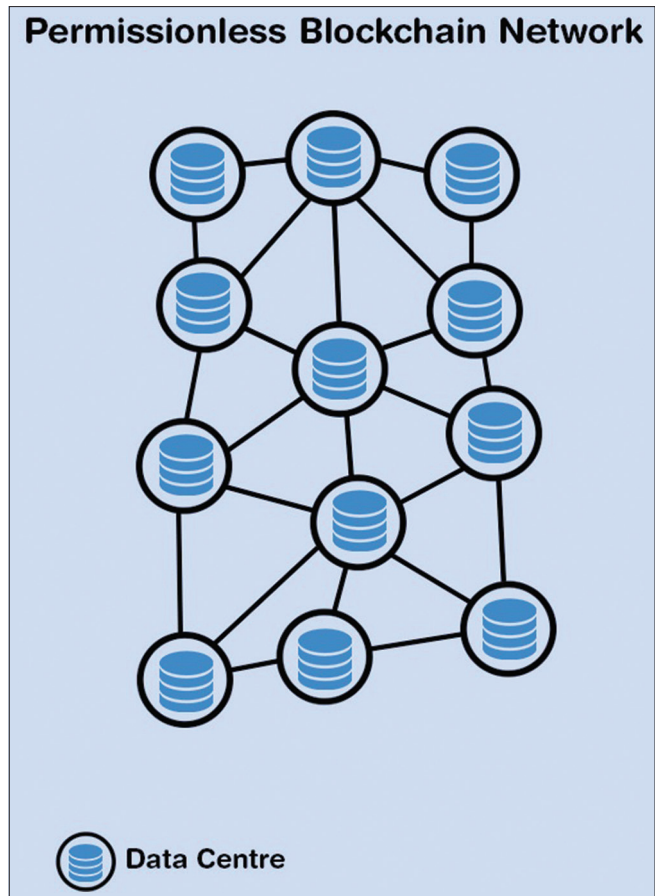
of practitioners and organizations that capture digital data, which could be a barrier for blockchain technology. The highlight features of this manuscript are to create cognizance among ophthalmologists about the blockchain revolution in the field of ophthalmic AI and its importance in big data management. Thus, more practitioners and organizations from developing countries are encouraged to capture and store as much digital data as possible to contribute to this technology, as blockchain technology is a peer-to-peer network where everyone is connected to the network and has a copy of the current database as and when it is updated.

Many practical applicative fields where blockchain technology has already been incorporated are as follows:
- Non-fungible token (NFT) marketplaces
- Music royalties tracking
- Cross-border payments
- Real-time data streaming in Internet of Things (IoT)
- Personal identity security
- Anti-money laundering tracking system
- Supply chain and logistics monitoring
- Voting mechanism
- Advertising insights
- Original content creation
- Cryptocurrency exchange
- The real estate processing platform
- Health care systems
- Digital currency conversion

Blockchain technologies are inevitable in the near future and their incorporation in the field of ophthalmic AI for big data management in developing countries is only a matter of time. It is very important that ophthalmologists must be aware of this fact and equip themselves with this technology.

Challenges of Blockchain Technology

- Selecting the appropriate blockchain platform is crucial. Permissioned blockchain-enabled platforms [Fig. 1] (based on Hyperledger Fabric) should be given priority over permissionless blockchains [Fig. 2]. Users should be cognizant of the workflow changes required if blockchain is adopted.
- Mindsets deeply rooted in the traditional distributed database management system (DDBMS) need to be changed.
- There are significant costs involved in the investment in blockchain technology.
- Immutability of the blockchain platform will prevent amendments of erroneous entries.
- Cryptographic flaws could leave vulnerabilities within the blockchain platform.
- Decentralized peer-to-peer transactions may compromise patients' data if it has not been anonymized. The blockchain algorithms need to undergo extensive trials and penetration tests to guarantee that the patient's privacy and confidentiality are upheld.

Conclusion

Blockchain-based solutions for the management of AI research datasets and model testing offer the advantages of data integrity, data immutability, automation in data consistency, shared ledger promoting easier collaboration, and increased validation and transparency. It will also allow health regulators such as the US Food and Drug Administration to effectively audit and verify the diagnostic performance of AI algorithms for approval. In addition, an ideal digital infrastructure is provided by blockchain technology to track each iteration of the AI-model training, thus improving collaborative efficiency and trust. Despite various advantages, there are certain important pitfalls of blockchain, such as the democratization of data sharing, which should be acknowledged. Democratization of data at the patient level might not materialize due to privacy preservation, thus failing to convince and motivate patients to proactively share their data. It may be more realistic to consider the monetization of big data at an institutional level. However, even that strategy faces significant resistance for fear of privacy breaches or the loss of autonomy over valuable data.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Ng WY, Tan T-E, Xiao Z, Movva PV, Foo FS, Yun D, *et al*. Blockchain technology for ophthalmology: Coming of age? Asia Pac J Ophthalmol 2021;10:343-7.
2. Nakamoto S. Bitcoin: A Peer-to-Peer Electronic Cash System. Available from: www.bitcoin.org. [Last accessed on 2020 Nov 30].
3. Buterin V. A Next Generation Smart Contract & Decentralized Application Platform. 2015. Available from: https://www.semanticscholar.org/paper/A-NEXT-GENERATION-SMART-CONTRACT-%26-DECENTRALIZED-Buterin/0dbb8a54ca5066b82fa086bbf5db4c54b947719a. [Last accessed on 2022 Jan 17].
4. Hyperledger. An Introduction to Hyperledger. Available from: https://www.hyperledger.org/wp-content/uploads/2018/07/HL_Whitepaper_IntroductiontoHyperledger.pdf. [Last accessed on 2021 Mar 16.
5. Ramesh PV, Ramesh SV, Aji K, Ray P, Tamilselvan S, Parthasarathi S, *et al*. Modeling and mitigating human annotations to design processing systems with human-in-the-loop machine learning for glaucomatous defects: The future in artificial intelligence. Indian J Ophthalmol 2021;69:2892-4.
6. Ramesh PV, Subramaniam T, Ray P, Devadas AK, Ramesh SV, Ansar SM, *et al*. Utilizing human intelligence in artificial intelligence for detecting glaucomatous fundus images using human-in-the-loop machine learning. Indian J Ophthalmol 2022;70:1131-8.
7. Ting DS, Cheung CY, Lim G, Tan GS, Quang ND, Gan A, *et al*. Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes. JAMA 2017;318:2211-23.
8. Abramoff MD, Lavin PT, Birch M, Shah N, Folk JC. Pivotal trial of an autonomous AI-based diagnostic system for detection of diabetic retinopathy in primary care offices. NPJ Digit Med 2018;1:39.
9. De Fauw J, Ledsam JR, Romera-Paredes B, Nikolov S, Tomasev N, Blackwell S, *et al*. Clinically applicable deep learning for diagnosis and referral in retinal disease. Nat Med 2018;24:1342-50.
10. Dinh T, Thai M. AI and blockchain: A disruptive integration. Computer 2018;51:48-53.