

A Survey about Block Chain Technology for Machine Learning

Babitha Lincy R¹, Rajasvee S², Swetha G A³, Satya D⁴, and Ragul Ravi⁵

¹Department of CCE, Sri Eshwar College of Engineering Coimbatore, Tamil Nadu, India

^{2,3,4,5}Department of ECE, K.Ramakrishnan College of Engineering, Trichy, Tamil nadu, India

Abstract— Blockchain technology is an emerging technology, which is a shared, immutable ledger that keeps a track of transaction details in a commercial network. Nowadays the blockchain technology is most trending and disruptive technologies. Recently, none of the applications runs without machine learning technique. However, according to machine learning concept, for all the applications the neural nodes depend on centralised servers. The centralised server leads to single point failure problem. Thus, integration of machine learning concept with Blockchain technology provides numerous kinds of applications such as computerized and reliable governing the data, competent data market management, data protectivity and augmentation of the firmness of the deep learning-based systems. Therefore, the significance of the blockchain technology and machine learning is explored in this paper. This paper surveyed the possible existing blockchain based machine-learning framework and their comparative analysis. In addition to that stated the features and drawbacks of the existing frameworks. Furthermore, the paper considered four factors such as deep learning method, blockchain variety, consensus decorum, and dataset for comparing the existing frameworks. Finally, this paper illustrates future research directions for the development of trustworthy machine learning framework.

Keywords— AI, Machine learning, Blockchain, Smart contract, Transparency, Security.

I. INTRODUCTION

The supremacy of deep learning is evident from almost every industrial sectors. Especially, machine learning technique is very helpful for diagnosing the disease precisely in healthcare applications [1]. Recently, in the COVID-19 epidemic period, the benefits of machine learning in predicting the disease based on the symptoms played a crucial role [2]. The deep learning predicts the disease based on dataset of CT and X-ray images. In addition to that, machine learning is uses for screening process in Airport by security officers for identifying any suspicious or banned items in the passenger's luggage. Similarly, biometric authentication and face acknowledgement deep neural network model can contribute in a situation where any physical danger is occurred in real-time [3-6]. Also, the machine learning algorithm can be very useful for agriculture field for detecting and diagnosis plant disease. Therefore, the machine learning technique has reduced the manpower, time-consumption and increases the accuracy of prediction [7]. However, mostly, the machine learning technique harness the centralized storage for training the model. Thereby the machine learning technique is more prone to fall into a single point of failure. The Blockchain is a distributed technology that handled data with more efficiently, safety and concealment. The incorporation of blockchain with deep learning provides various features such as efficient data market

management, trusted decision making, training model sharing, data security and improved the sturdiness of the deep learning-created systems [8-11].

The initial phase of deep learning network is data assortment, which comprises data gaining, labelling and development. The first stage is very significant because in this stage only quality of the image will be improved [12]. The data should be collected large-sized and high-quality from multiple sources for increasing the training efficiency with real-world testing data. Further, the training on small dataset would not give effective result. The accuracy of the result is enhanced based on large quantity of dataset. Figure 1 represents the imperative applications and profits of deep learning methods with descriptions of their roles. The image recognition based deep learning method enables identifies the particular objects of faces. This kind of image identification process used to identify the number of faces or finding the location of the particular vehicle. Similarly, voice recognition technique used to control smart phone and smart homes based on voice-based commands. Moreover, recently OCR Optical Character Recognition technique has been employed nearly in all smartphones and apps for language translator and in edited page [13]. However, there will be a single-point failure problem since machine learning faces centralized data storage. Data is most important in deep learning technique. Thus, protecting data from external and internal attacks is very

significant. Also, the centralized data storage scheme is lead to very poor reliability since it is easily attacked by any fluctuations and scam [14].

Blockchain technology successfully handles the drawback of single-point failure. Blockchain is a radical technology that preserves a shared ledger of data among participants in a distributed network [15]. This technology verifies the proven consistent of the ledger copies of the participants. The salient feature of Blockchain technology is increasing the robustness of the deep learning models by preserving the data against from several attacks [16]. The blockchain uses temper-proof and temper-resilient technology for the robust security against any threats. Those two security techniques ensure the data has not been tampered when its created. The primary characteristics of blockchain technology includes data transparency, unchanging capability, traceability, provenance, security and operational visibility. The blockchain technology consists of a decentralized peer-to-peer (P2P) construction. In business point of view, the blockchain technology performs automation employing self-performing smart contracts. The smart contracts eliminate the role of third parties in implementing the services. Smart contracts ensure the smooth advancement of a swift, economic and consistent system for deep learning applications [17]. In [18], the consensus algorithm employed on the existing blockchain platforms that is used for achieving data integrity. Existing research works on blockchain describes three types of machine learning methods such as private, public and consortium blockchains. Among the three types of blockchains, the public type is more subjected to inference attacks while during money transactions, pseudonymous addresses and publicly available user data. Therefore, private and consortium platforms give security more than the public platform.







	Image analysis and interpretation in the form of classification, detection and segmentation		From data gathering to data comprehension, and using the data for automation
	Biometric and wearable device data is used for analysing the health of the patients		Smart voice assistants such as Alexa, Siri and Cortana uses deep learning to ensure flawless operations
	To extract the textual data from images (scanned documents and photos)		Smart text prediction to generate the message based on previous input.

Figure 1: Real-time Applications of Machine Learning Algorithm

Once created machine learning models can be utilized for training other different entities. However, the

blockchain ensure the attribution of the machine learning models, which leads to employed reliable Artificial Intelligence (AI) system. Thus, Blockchain technology induce the contributors to allocate their data, which is useful for practice, the hardware. While keeping machine learning based data in the blockchain network, provides reliable and error-free data transfer or communication [19]. Because, blockchain network have the characteristics of not duplicating, missing or noise data. These features are necessary present for the stable and reliable for AI based models. Thus, combining both machine learning technique with blockchain technology brings many advantages such as effective authenticity assurance, audit trails, effective data management and presenting new dimension to the commercial process over computerization by smart contracts. The smart contract facilitates the medical field that without the third-party involvement, the system will recall the authorities about the medicine expiration.

II. RUDIMENTS

This segment precisely explains the fundamental knowledge of blockchain technology and machine-learning technique. Then the incorporation of both the technologies and their features are stated. Some of the benefits are build a trusted network, enhanced robustness and automatic decision-making.

A. Blockchain Technology

Blockchain has the ability to make the system complicated for hackers to modify, incorporate or delete the information. The salient feature of decentralization technology is the reason for the robustness of the difficulties present in centralised network. The decentralized technique is used to store data and process the data for data transactions. The blockchain technology uses point-to-point architecture. Each node in a decentralized network is the responsible for storing and verifying the data. The information of transactions is stored in the arrangement of blocks in the network. Every block in a blockchain technology play a vital role. The primary building block of this novel technology is blocks. A black can store the memory of transactions and based on these transactions, it will ensure the correct form of the existing blocks. Through this the correct chain will be maintained if any new blocks have been incorporated. The added new blocks in a local chain, the information regarding the new block has been propagated to all nodes for ensuring data consistency [20]. The new block will be added with the help of miner node. The data consistency in terms of blockchain technology is the property of immutable or delete the

block or node. Moreover, the miner node is the responsible for validating the blockchain validation and approved by the miner nodes. The consensus protocols are very helpful for the blockchain to maintain the robustness against security. The Proof-of-work and Proof-of-stake are two important consensus protocols which keeps the information safe from internal and external hacking attack. Another main feature of blockchain technology is smart contract [21]. The smart

contract is an electronic program which comes into action only when the predetermined conditions are satisfied. The utilization of smart contract mitigates the challenges and financial need for the business. Thus, the additional features of the Blockchain technology such as decentralized network, data immutability and smart contracts enhances the effectiveness of the business field. The salient features of Blockchain technology have been illustrated in figure 2.

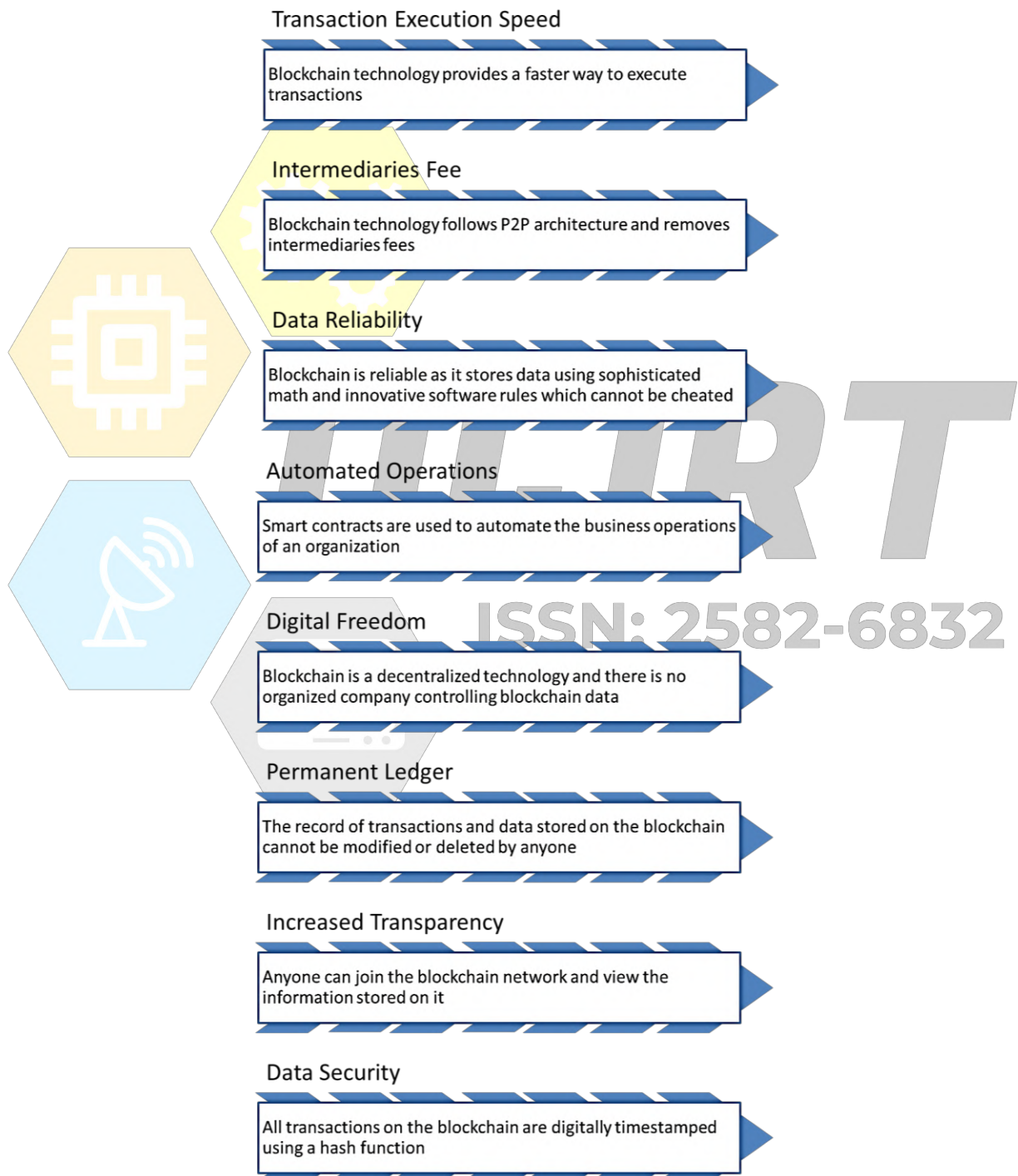


Figure 2: Features of Blockchain Technology

Though the Blockchain technology has many numbers of advantages, it has some issues. Because, for a large sized data application the blockchain technology became costlier than ever. Unless or until the appropriate approach are involved to minimize the large-sized data. Especially the healthcare data became very large in size since it stores medical records, medical history of patients, diagnoses, medications. The pointers and linkers are play a crucial role for reducing the large data size. Moreover, the decentralized data storage method provides more security against single-point failure-based complications. There are some of the commonly used blockchain decentralized platforms such as Cassandra, Swarm, Storj and OrbitDB.

B. Deep Learning

Deep learning enclosed inside AI and machine learning as shown in figure 3. The latent space representation of the data can be trained to learn the deep learning model in the existing scheme. The data can be any form in images, speech and text signals. The deep learning train the hardware to execute the applications with human-like accuracy or even better accuracy than humans. The wide range of deep learning applications in different fields such as image classification, object detection, self-driving cars, disease prediction and voice control are desired cases of deep learning technique. Similarly, the deep learning models can be trained using large number of labelled data [22].

The data representation algorithms help the machine learning algorithm to understand the globalized data sequences. Decision taking is very important in deep learning technique. For that, the accuracy of the data plays a crucial role for taking suitable decision. For example, if the data consists of inadequate information, irrespective of how large the algorithm is, the deep learning model will not perform well on this data. Therefore, feature extraction engineering reconstructs the inadequate data by exploiting the features for the raw data. However, the deep learning models are very smart and intelligent, they will extract the feature or high latent space features from the basic form of data. Not only that, the deep learning models naturally consists of many layers. The lower-level layers are responsible for extracting lower-level features. Similarly, the high-level layers can extract the higher level of abstract features from the input data. The number of layers in the deep learning model decides the precision and security.

Adjusting the hyper-parameters of the deep learning model is considered as a tedious task for achieving

moderate performance. The important factor of scalability is related with the choice of network topology on which the deep learning model is employed. The deep learning model can observe the data pattern in the internet traffic and learns form them to train a model to distinguish cybersecurity threats. There are various cyber security threats in the internet such as malware, social engineering, data breaches, inside attackers and Denial-of-service (DOS). These cyber-attacks have filched the user’s private information for destructive purposes.

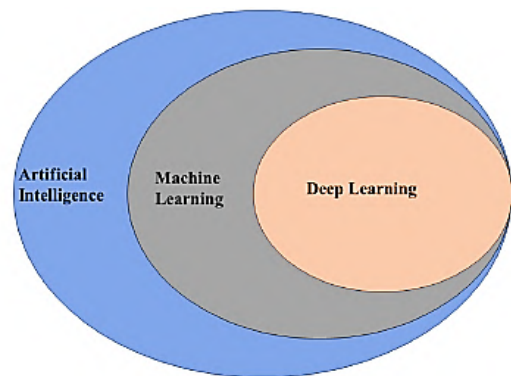


Figure 3: Association between AI, Machine learning and deep learning

Deep learning model can resist towards the above-stated attacks. Thus, the model used to detect the interruption and avoiding it from happening in the future. The deep learning model verify the transaction signatures in the internet traffic for any intrusion is there. And immediately informed to the user about the threat detected through blockchain smart contracts. Further, the deep learning model identify any suspicious activities the data traffic to detect bad actor and malware. The social engineering related data theft attacks can be identified Natural language processing (NLP). NLP is one of the subtypes of the deep learning.

C. Blockchain based Deep learning

The indispensable prerequisite of reusability and trusted sharing of deep learning has been fulfilled by Blockchain technology. The reason behind the combination of deep learning and blockchain technology is for various salient features such as data verification, auditability, attestation of results, provenance, traceability of ownership. The large diverse dataset is fed back to the deep learning models. The large data will be used for learn the features and provides the probability vector outcome [23]. Nevertheless, deep learning model extremely worked well in the case of raw data, it is still required to improve the accuracy of the

data during the prediction of real-world data. The important features of blockchain based deep learning model is illustrated in table 1.

Figure 4 explains the salient features of the blockchain and deep learning model integration. Blockchain is a fault-tolerant technology which secure the data against many attacks. The deep learning uses those secured data to train the model and gives accurate results. Similarly, the primary property of blockchain's data immutability, prevent the data affect from many attacks and data noise issue. Thus, the outcome of the prediction enhances the trustworthy and accurate among the data. The incorporation of blockchain and deep learning technologies can open many research doors towards automation of several tasks. The automation requires careful data handling and high security. The combination of deep learning with blockchain gives stable, permanent and decentralized infrastructure for the deep learning-driven applications. The following summary provides the features and aspects of blockchain and deep learning integration.

Data security: Since the blockchain is a decentralized technology, the information stored in a block is always safe and secure. Private blockchain is one of the types of blockchain which is very effective for storing and processing private and confidential information. Deep learning algorithms can be worked on stable data is provided by blockchain. So that it exhibits trustworthy, accurate and reliable decision making.

Automatic decision making: Blockchain follows point-to-point (P2P) technique for data processing. The

traceability feature in the blockchain mitigate the challenges over verifying the decision making [24].

Cumulative Judgements: Self-governing digital negotiator takes decision depends on the collected data to a specific application. The examples for the cumulative judgement are swarm robotics and deep reinforcement learning. The voting-based method is used the robot to take decision depends on the data composed by the swarm robots.

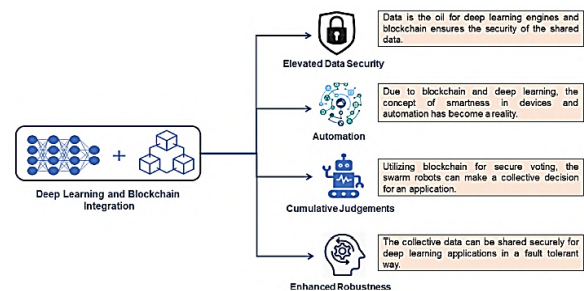


Figure 4: Outcome applications of the combination over deep-learning and blockchain

Enhanced Robustness: In some cases, the deep-learning model can exceed the human-level accuracy. Thus, the stakeholder invests their hope and trust in the deep-learning models. Moreover, the blockchain is a decentralized technology is added their robustness of the deep-learning model. Therefore, the incorporation of blockchain with deep learning model, provides valuable business forum applications. This forum supports the parties to work with trust-less and automatic environment.

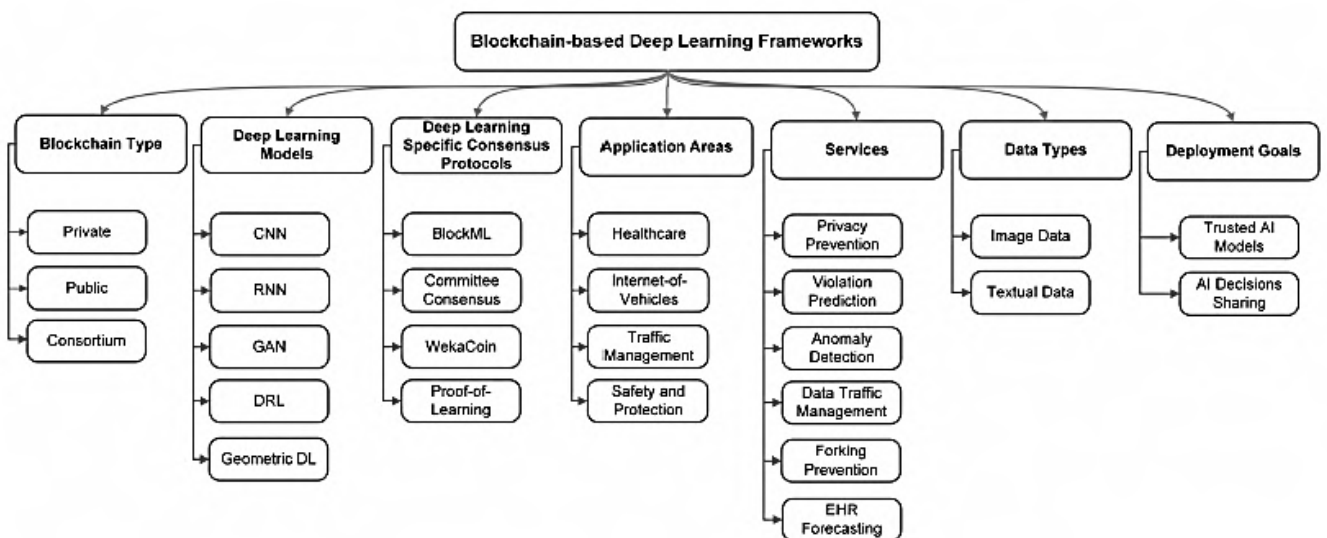


Figure 5: A taxonomy for blockchain for deep learning applications

III. TYPES OF BLOCKCHAIN

The Blockchain technology consists of various types related to the existing blockchain stages. Most of the deep learning associated systems and models depends on time-related restraints. According to the design, features and strategies of the blockchain platform is measured as the prevailing deep-learning frameworks. Moreover, the blockchain is classified as public, private and conglomerate/federated segregated as follows.

A. Public Blockchain

The public blockchain platform is built by the remaining blockchain based deep-learning outlines. The public blockchain platform supports not authorized or unobstructed access among the disseminated ledger by the user or machine learning devices. That is all the users of the particular distributive network can use same ledger copy among all nodes and can perform the transactions. The public blockchain platform maintain the anonymity transactions due to the decentralized data cache and operation. In addition to that the public blockchain platforms provides robustness against various types of outbreaks. Thus, the blockchain leads the deep learning models gives the correct and trustworthy outcomes.

B. Private Blockchain

The deep learning based blockchain frameworks exploits single entity called private blockchain platforms. The isolated blockchain platform are supervised and achieved with a solitary entity. The private platform is entirely depending on permissioned authority. Here, the permission domination standing between the supervision unit. The knowledge of the identities of the validators of the nodes are fed back to the essential authority. Thereby the private blockchain network entails fewer challenging scientific operations to check the business dealings. Hence, the processing speed of the private platform is advanced than the public blockchain platform.

C. Consortium/Federated Blockchain

The prevailing blockchain based deep-learning architecture can exploits the consortium blockchain platform. Then the specified platform consists of the characteristics and features of the aforementioned both the blockchain platforms. Anyone can access the consortium blockchain platform, since it is an authorization network. At the same time multiple heterogenous groups can access the authorization role. The consortium network is different from private platform that multiple administration is accountable for

supervising and handling the consortium network. To summarize about the concept, anyone can access the consortium platform, however certain sanctioned cluster of nodes can affix the ledger. Furthermore, the processing speed of consortium platform is higher than the public blockchain platform.

IV. RESEARCH CHALLENGES AND OPPORTUNITIES

This part is especially discussing various research directions and open research challenges of incorporation of both the massive technology such as deep learning and blockchain. The major limitations that are prevents the effective incorporation of the two massive technologies comprises transaction execution latency, declaration of protected information interchange, platform scalability, huge amount of data from sensors and biomedical wearable components, platform interoperability support and operationally exclusive consensus protocols. The above-said challenges and issues are discussed in the following sections.

A. Platform scalability

The issue called scalability is mainly affects in the architecture field of application. Because of the limited accessibility of several alternatives and formations of blockchain technology. The parameter scalability is a measure of the handling efficiency when the large quantity of data is present. And the speed of communications is produced by miscellaneous operators. The scalability factor is very helpful for processing large quantity of data such as healthcare, transport congestion and obstruction administration in mobile networks [25]. The exploitation of blockchain on such a huge scale will lead to certain serious issues. That limitations are associated with data transfer speed, internet connectivity and quantity of communications generated by contributing nodes. The compression algorithm is used to mitigate the effects of scalability issue that are present in the blockchain. The additional features of the weightless design, high compression ratio and economical hardware resources of compression method is an extra credit to the utilization of the existing blockchain. Nevertheless, all the compression algorithms won't fit for the advantage of blockchain because of the deep learning-based services.

B. Data Legitimacy and protected sharing

The data in a healthcare industry between the participants such as physicians, nurse and patients should be reserved unidentified. The anonymous condition of the blockchain is due to the private

blockchain platforms. The encryption and decryption process are carried out by the private blockchain platform. The emerging two great engineering fields of IoT and wearable strategies in medical and transport applications requires maximum privacy, secure and confidentiality. For that multi-layer blockchain network will be used for the data privacy [26]. The multi-layer blockchain have the provisions of data combination and innovative verification scheme for the secure data communication. The characteristics of validation and archiving immutable data are helps to ensure the authenticity of the data. The blockchain platform is considered as a fundamental for many research ideas. Moreover, the blockchain supports the companies and organizations share their knowledge and expertized in a reliable and trusted way. However, the data collected from vehicle to the IoT can be mostly faulty and inappropriate[29, 30]. Therefore, Metadata binding is a method of collecting data from IoT devices along with accuracy and precision level of collected information in a blockchain. Not only that, the metadata should be checked or verified for any attacks before storing on the blockchain. The verification is done by the smart contracts. Smart contracts play an important role to confirm only the apparent units is stored on the blockchain.

C. Organizational augmentation and storage volume

Deep-learning technology is a elements rich technology. Thus, many optimization methods have been implemented for overcoming various real-world challenges. Blockchain technology guarantees the data stored in a channel is extremely protective, unchallengeable, confirmable, translucent and observable to the sanctioned stakeholder. The deep learning optimization algorithms helps the blockchain to attain economical efficient performance [27, 28]. The deep learning framework not only used for detecting the real-world objects and classification but also in compression process. However, blockchain network will keeps on adding ledger for the efficient and secure data transfer. Thus, the size and storage area will be increased as so on. Thus, the requirement of area consumption for storing the data is inevitable and challenging task.

V. CONCLUSION

In this paper, the fundamental concepts and existing blockchain-based deep learning framework has been reviewed. This article offered the salient attributes of blockchain and deep learning technique. Moreover, this paper highlights the benefits of the amalgamation

between blockchain and deep learning technology. Also, the real-world applications of the integration are stated. The effective incorporation of deep learning with blockchain can simplify the important factors such as data protectivity and confidentiality. Thereby improve the eminence of systems in various applications such as health care, block chain security, vehicular communication and data traffic management. Many types of deep learning based blockchain frameworks in the literature has been studied and analysed with the comprehensive report. From that, we came to know that the technological and social challenges for the open research directions. Hence, this paper is very helpful and bring knowledge to the researcher at the initial stage.

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