2019 Fifth International Conference on Science Technology Engineering and Mathematics (ICONSTEM)

Artificial Intelligence Integrated Blockchain For Training Autonomous Cars

G. Meera Gandhi
Computer Science and Engineering Department
Sathyabama Institute of Science and Technology
Chennai, India
meeragandhi.cse@sathyabama.ac.in

Salvi
Computer Science and Engineering Department
Sathyabama Institute of Science and Technology
Chennai, India
salvichaudhary@gmail.com

***Abstract*—Artificial Intelligence integrated Blockchain proposes an integration of Artificial Intelligence and Blockchain Technology, the two most cutting-edge technologies of recent days, which in turn is capable of opening a wide spectrum of opportunities that can be termed as revolutionary in the field of technology. This idea of an artificially intelligent blockchain can be used to simplify the learning process of autonomous, driverless, self-learning cars significantly by utilizing blockchain for imparting the learned information. Autonomous cars learn using reinforcement learning. Take training a driverless car to apply break when it comes close to a wall for instance. At first, the car keeps driving until it hits the wall for a number of times. These experiences get stored in its memory and after a few collisions, the car learns from its experience that it needs to stop when it reaches too close to a wall. In current industry, each car is trained individually until each of them learns when to stop automatically to avoid collision. This paper proposes that each car should be connected to a shared public ledger where they can share their experience so that all the cars possessing that shared ledger can learn when to stop from the experience of one single car thereby eliminating the cumbersome task of training each car separately. This collective learning can be carried out using Blockchain Technology.**

Keywords*—*Blockchain Technology, Ethereum, Artificial Intelligence, Autonomous, Driverless cars, Self-driving cars, Information Imparting, Public ledger, Collective learning

I. Introduction

Artificial Intelligence and Blockchain Technology are undoubtedly the two most recent and trending domains of today's world with a huge scope of development. While Blockchain Technology itself is a transformative step, the integration of Artificial Intelligence with it can bring a major change in current technology. Where Blockchain provides a convenient means of value embedded data exchange, AI enables putting those data into action without much of human efforts. These two technologies, when implemented
together, might bring out a change that can be termed as revolutionary in the field of technology.

Mostly when we talk about blockchains, people tend to relate it to cryptocurrency. Although it is one of the most popular applications of blockchains till date, blockchain technology is not simply restricted to cryptocurrencies. It has a huge number of other significant applications which, when put into use, can bring about a drastic change. One such major application is information imparting.

Blockchain uses a concept of shared public ledger in which all the transactions happening between all the nodes of that blockchain network are noted down. Each node in a blockchain has an identical copy of that ledger. Hence, any activity made by any of the nodes is visible to all other nodes in that network. This decentralized nature of blockchain makes it a powerful tool for imparting information to a chain of entities at a time. Therefore, blockchains can be used as an efficient tool for information sharing.

II. Problem Statement

The main idea is aimed to simplify the training process of autonomous, self-driving, driverless cars using an artificially intelligent blockchain network of a number of autonomous cars. At present, each car is trained individually until each of them learns how to drive safely on roads without any accident. Training an autonomous car to drive safely just like a human does is a cumbersome task. It involves lot of resources, time and human efforts before a car finally learns to drive on its own. Knowing that training one car itself is a tedious task, it can be imagined how hard can it be for a production company to train all its autonomous cars individually, one at a time. For example, if thousand cars are produced in a lot, all of them will have to be trained separately. Hence, the same training algorithms have to be carried out again and again for thousand times.

This paper proposes a technique to train all the cars produced in a lot just by training one single car, i.e., only one car has to be trained using reinforcement learning and rest all other cars in that lot will automatically learn driving just from that one single car's experience simultaneously thereby reducing the resources, time and efforts required by a significantly large extent.

III. Literature Survey

The literature review for the above said proposal includes a thorough research on two different domains. One explores various techniques that are being followed currently to train driverless cars and various ideas implemented to make it more and more efficient whereas the other research explores the possibilities of various applications and use-cases where blockchain technology can be used efficiently to achieve a simplified implementation of rather difficult tasks.

978-1-7281-1599-3/19/$31.00 ©2019 IEEE

Pinyaphat Tasatanattakool, Chian Techapanupreeda [1] in the paper "Blockchain: Challenges and Applications" discusses various applications that can be carried out using Blockchain Technology. The paper stresses on how people often confuse blockchain with Bitcoin which, in reality, is just one of the many applications of Blockchain Technology.

Shuai Wang, Jing Wang, Xiao Wang, Tianyu Qiu [2] in the paper "Blockchain Powered Parallel Healthcare Systems Based on the ACP approach" proposes to use blockchain for data sharing in a hospital management. The paper elaborates the use of blockchain as a decentralized logbook to track the various activities taking place in that hospital.

Rahul A. R. [3] in the paper "AI in Blockchain Technology: The possibilities of integrating AI with Blockchain" discusses a number of possibilities that arises in our day to day life when these two mega domains are integrated.

Through a research of a number of journals and pre-existing research papers, various techniques that are currently being used to train autonomous cars through artificial intelligence are analyzed. Most of the sources indicate the usage of reinforcement learning with deep learning algorithms to carry out the training task. The current training technique has a wide scope of further improvement as the domain is relatively new and it has not been too long since autonomous cars have come to existence.

Only after a thorough research on both the domains, the idea struck that the key to simplify the training task of one of the most technologically advanced invention of decades lies in Blockchain Technology and that the difference this implementation can bring about is significantly very huge.

IV. Existing Method

- Existing system for training autonomous cars involves training each car separately one by one until they have enough experience to drive safely without any accident
- Various Deep Learning algorithms are used with high precision to make the car learn to drive on its own.
- The car learns how to respond to its surrounding in an intelligent way through reinforcement learning.
- But the main drawback of this otherwise efficient system, that this paper aims to bring forth, is that this training procedure has to be carried out with all the cars separately.
- Each car has to be trained one by one individually.
- This task requires a lot of resources, time and human efforts.
- For the current mechanism in practice, the no. of times you need to carry out the training procedure is equivalent to the total no. of autonomous cars produced.
- When seen from industrial point of view where productions are always in bulk (some hundreds or thousands of cars are produced at a time) for mass usage, this system can really be a humongous task.
- The speed at which technology is improving and the way it is fascinating us, the day is not far when autonomous cars become frequented on roads.

All these points clearly indicate that it will be very useful if this training process can be made simpler and some modularity can be introduced to this process to speed it up and make it more efficient.

V. Proposed System

A system is proposed to simplify the training process of autonomous cars. This system is capable of training a huge number of cars at a time by implementing the training task just once instead of implementing it again and again for each car separately.

The proposed system talks about an integration of Artificial Intelligence and Blockchain technology for this purpose. Blockchain technology provides a concept of a public ledger where all the activities happening within the nodes of a blockchain network are recorded in the form of log entries. All the entries made by any of the nodes on the blockchain network is visible to all other nodes. This concept of having a shared public ledger can solve the problem discussed above. The proposed system aims at training a huge number of cars just by training one single car and sharing that car's experience to all other cars on that network via blockchain technology.

A. How Blockchain Technology Works?

Wikipedia defines blockchain as [4] "...a decentralized and distributed digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the collusion of the network." The shared digital ledger keeps a record of all the transactions happening between the nodes of a blockchain network. It is similar to a register or a log book. These ledgers can be a powerful tool for **data sharing**.

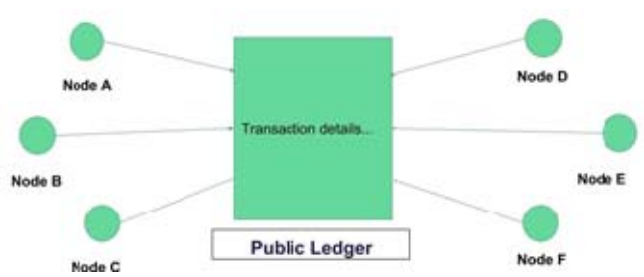

Fig. 1. Concept of public ledger

Fig. 1. shows the concept of public ledger where the log of each transaction gets recorded. Each node possesses an identical copy of this ledger. Any change made by any of the nodes instantly gets reflected on the ledgers of all the nodes in the blockchain network.

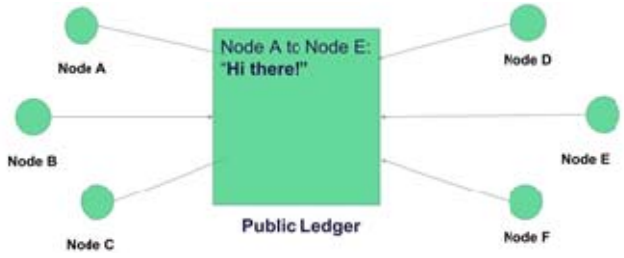

Fig. 2. Recording Transactions

Fig. 2. shows a case where node A sends a message "Hi there!" to node E. This transaction gets updated in the public ledger instantaneously. All the copies of this ledger also get updated with the same details. Fig. 2. illustrates the process of updating the information regarding the transaction diagrammatically for reference. Thus, any transaction made in the network is visible to all the subsequent nodes of that blockchain irrespective of whether a particular node is involved in that transaction or not.

This decentralized nature of blockchains can be put to use to impart information which in turn is the key of our proposed system.

B. How Blockchain can be Used to Train Autonomous Cars?

The proposed system suggests to create a blockchain of a number of autonomous cars and then train any one of these cars using reinforcement learning and other artificial intelligence algorithms. For instance, assume a task of training hundred cars to apply brake when it reaches too close to a wall in order to avoid accident. All the hundred cars are put into a blockchain network and then any one of them is trained. The trained car learns to stop when it reaches too close to a wall through its experience. This car then updates this experience on the public ledger stating "stop if proximity<=10 m else you'll hit the wall". Since each car in the network has a copy of this public ledger, all the cars connected to this blockchain network learns that "they need to stop if proximity<=10 m else they'll hit the wall". Thus, hundred cars can learn from the experience of one single car. A diagrammatic representation of the proposed idea is shown in the figures below with an instance of four cars.

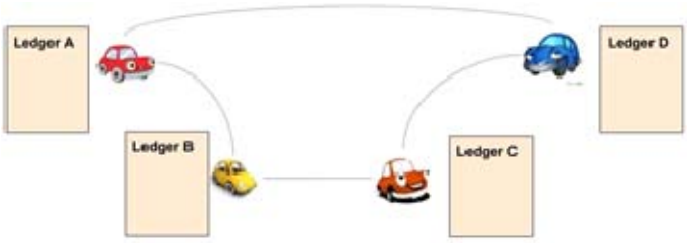

Fig. 3. Blockchain network of cars

Fig. 3. depicts the blockchain network of cars. Each car possesses one copy of the public ledger as shown.

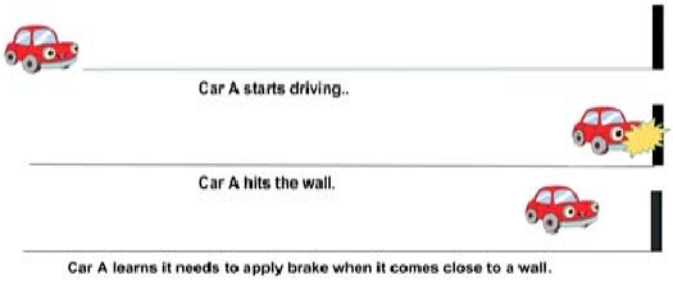

Fig. 4. Training one of the cars

Fig. 4. shows the process of training one car using reinforcement learning. The car, from its experience, learns at what distance should it apply break in order to avoid collision if it comes too near to a wall. This training is carried out by various machine learning and deep learning algorithms.

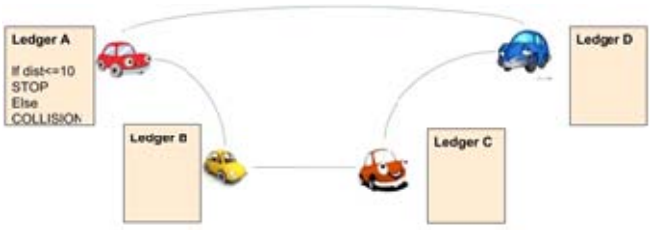

Fig. 5. Car A updates on its ledger

In fig. 5, it is shown that car A updates its experience in its ledger stating "If distance<=10m STOP else COLLISION".

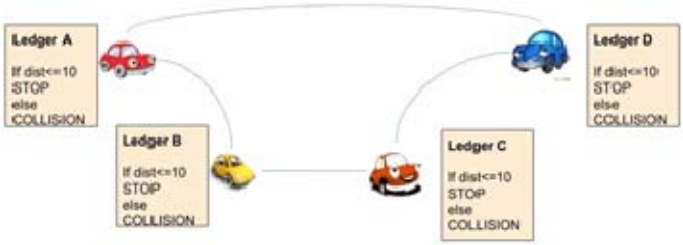

Fig. 6. Automatic updation in all other copies of the ledger

Fig. 6. shows that as soon as any of the ledger gets updated, the same changes are reflected in all other ledgers thereby adhering to the decentralized, transparent and distributed nature of blockchains. All the cars in the network has this experience stored in their memory. Thus, they all were getting trained simultaneously when car A was being trained.

Hence, number of times the training process has to be carried out is just once. Any number of cars can be trained by this method by carrying out the training process just once.

C. Adding Modularity to the Process

The advantages of the proposed system are not only restricted to reducing the number of times the training process has to be carried out, instead this system adds a wide scope of modularity in the process making it very flexible. Since all the cars share one shared memory, each car can be trained for different tasks at a time and all of them can learn all the tasks at the same time. For instance, while one car is being trained to stop when it comes close to a wall, another car can be trained to stop when the traffic signal is red, on the other hand another car can be trained how to respond to another moving vehicle at the same time. Since all these experiences and learned information go to the same shared memory, the car which is learning when to apply break in order to avoid collision can simultaneously learn how to respond to moving vehicles and to stop when the signal is red at the same time. This feature opens up another set of wide range of advantages reducing the complexity to an even larger extent.

The proposed system paves way to an intelligent intersystem communication without much of human involvement. It is more like a group of intelligent cars talking to each other, sharing their piece of information with each other.

VI. Conclusion

As a huge number of cars can learn collectively from the experience of one single car, the need of implementing the training algorithm decreases from implementing it as many times as there are number of cars available to be trained to just once. The complexity of the procedure reduces from n to 1, where n can be as big as it can.

The difference that the proposed method can bring over the existing method for a task of training 100 autonomous cars at a time is tabulated below as an instance for better understanding:

TABLE I
COMPARATIVE ANALYSIS

Parameters	Existing Method	Proposed Method
No. of cars to be trained	100	100
No. of times the training procedure has to be carried out	100	1
Relative Complexity	N	1

The proposed method improves the existing method of training driverless cars significantly by:

- eliminating the necessity of training each car separately.
- enabling thousands of cars to interact and share their experience.
- saving time, money and resources significantly.
- reducing human efforts to large extent.
- providing modularity in the process of learning.

Thus, integrating blockchain features to the training process of autonomous cars enhances its efficiency to a considerably large extent.

VII. Future Work

We have proposed introducing blockchain technology to the training process of autonomous cars in this paper. Future work will focus on embedding the training algorithms within a blockchain network in order to put the proposed system into action. Also, the future work will explore the extent of modularity that this system can bring forth making the learning process more and more simple and flexible.

References

[1] Pinyaphat Tasatanattakool, Chian Techapanupreeda (2018), "Blockchain: Challenges and Applications", 2018 International Conference on Information Networking (ICOIN), DOI: 10.1109/ICOIN.2018.8343163.

[2] Shuai Wang, Jing Wang, Xiao Wang, Tianyu Qiu (2018), "Blockchain Powered Parallel Healthcare Systems Based on the ACP Approach", IEEE Transactions on Computational Social Systems, Pages:1 - 9, DOI:10.1109/TCSS.2018.2865526.

[3] "AI in Blockchain Technology: The possibilities of integrating AI with Blockchain", Rahul A R, Accubits Technologies.

[4] Andrei Marinescu, Ivana Dusparic, Siobhann Clarke (2017), "Prediction-Based Multi - Agent Reinforcement Learning in inherently Non-Stationary Environments", ACM Transactions on Autonomous and Adaptive Systems (TAAS), Volume 12 , Issue 2, Article No. 9, DOI: 10.1145/3070861.

[5] Danny Shapiro (2016),"Accelerating the Race to Autonomous Cars", Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, August 2016, Pages: 415-415, DOI: 10.1145/2939672.2945360.

[6] Wikipedia "Blockchain", " https://en,wikipedia.org/wiki/Blockchain".

[7] Nakamoto S., "Bitcoin: A peer-to-peer electronic cash system".

[8] Thang N. Dinh, My T. Thai (2018), "AI and Blockchain: A Disruptive Integration", Computer, Volume: 51, Issue: 9, Pages: 48-53, DOI: 10.1109/MC.2018.3620971.

[9] Rui Qin, Yong Yuan, Fei-Yue Wang (2018), "Data Sharing and Tracing Scheme Based on Blockchain", 2018 8th International Conference on Logistics, Informatics and Service Science (LISS), DOI: 10.1109/LISS.2018.8593225.

[10] Lyubomir Stoykov, Kaiwen Zhang, Hans-Arno Jacobsen (2017), "VIBES: Fast blockchain simulations for large-scale peer-to-peer networks: demo", Proceedings of the 18th ACM/IFIP/USENIX Middleware Conference: Posters and Demos, Pages: 19-20, DOI: 10.1145/3155016.3155020.

[11] Hans-Arno Jacobsen, Mohammad Sadoghi, Mohammad Hossein Tabatabaei, Roman Vitenberg, Kaiwen Zhang, (2018), "Blockchain Landscape and AI Renaissance: The Bright Path Forward", Proceedings of the 19th International Middleware Conference Tutorials, ACM, Article No. 2, Rennes, DOI: 10.1145/3279945.3279947.

[12] Y. Yuan, F. Y. Wang (2016), "The Development Status and Prospects of Blockchain", Acta Automatica Sinica, vol. 42, no. 4, pp. 481-494, 2016.

[13] Huanrong Tang, Ning Tong, Jianquan Ouyang (2018), "Medical Images Sharing System Based on Blockchain and Smart Contract of Credit Scores", 2018 1st IEEE International Conference on Hot Information-Centric Networking (HotICN), DOI: 10.1109/HOTICN.2018.8605956.

[14] Matthias Mettler (2016),"Blockchain technology in healthcare: The revolution starts here", 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom), DOI: 10.1109/HealthCom.2016.7749510.

[15] Lucian Busoniu, Robert Babuska, Bart De Schutter (2008), "A Comprehensive Survey of Multiagent Reinforcement Learning", IEEE Transactions on Systems, Man and Cybernetics, Part C (Applications and Reviews), Volume: 38, Issue: 2, Pages: 156 - 172, DOI: 10.1109/TSMCC.2007.913919.

[16] Alex Dominguez-Sanchez, Miguel Cazorla, Sergio Orts-Escolano (2017), "Pedestrian Movement Direction Recognition Using Convolutional Neural Networks", IEEE Transactions on Intelligent

Transportation Systems, Volume: 18, Issue: 12, Pages: 3540 - 3548, DOI: 10.1109/TITS.2017.2726140.

[17] Kichun Jo, Junsoo Kim, Dongchul Kim, Chulhoon Jang, Myoungho Sunwoo (2015), "Development of Autonomous Car - Part II: A Case Study on the Implementation of an Autonomous Driving System Based on Distributed Architecture", IEEE Transactions on Industrial Electronics, Volume: 62, Issue: 8, Pages: 5119-5132, DOI: 10.1109/TIE.2015.2410258.

[18] Khaled Salah, M. Habib Ur Rehman, Nishara Nizamuddin, Ala Al-Fuqaha (2019), "Blockchain for AI: Review and Open Research Challenges", IEEE Access Volume: 7, Pages:10127-10149, DOI:10.1109/ACCESS.2018.2890507.

[19] Nebula AI (NBAI) - Decentralized AI Blockchain Whitepaper, Montreal, QC, Canada: Nebula AI Team, 2018.

[20] Shuai Wang, Yong Yuan , Xiao Wang, Juanjuan Li, Rui Qin, Fei-Yue Wang (2018), "An Overview of Smart Contract: Architecture, Applications and Future Trends", 2018 IEEE Intelligent Vehicles Symposium (IV), DOI: 10.1109/IVS.2018.8500488.

[21] Jeff Daniels, Saman Sargolzaei, Arman Sargolzaei, Tareq Ahram, Phillip A. Laplante, Ben Amaba (2018), "The Internet of Things, Artificial Intelligence, Blockchain, and Professionalism", IT Professional, Volume:20, Issue: 6, Pages: 15-19, DOI: 10.1109/MITP.2018.2875770.