Autonomous Vehicles and Blockchain Technology Are Shaping the Future of Transportation

Panagiota Georgia Saranti(✉), Dimitra Chondrogianni, and Stylianos Karatzas

Department of Civil Engineering, University of Patras, Patras, Greece
psaranti@gmail.com

Abstract. In this paper, the possibility of using the autonomous vehicles with the contribution of Blockchain technology as part of a service is examined. As a first step a short Literature review of Autonomous Vehicles as well as Blockchain technology is provided. Blockchain is another newly established technology and its main purpose is to facilitate secure online transactions. Furthermore, through this paper it is explained that together Autonomous vehicles and Blockchain technology could provide the end user with cleaner, more economical and efficient transportation. In addition, a publicly owned system is described, where the two technologies combine, and the autonomous vehicle will provide the user the most convenient route based on real-time traffic information, while Blockchain will make the economic transaction easier since it could allow peer-to-peer carsharing and eliminate the need for banks. Moreover, in order to fully understand this system, the rising concerns regarding these technologies are mentioned. This paper aims to examine such a possible service using autonomous vehicles and Blockchain technology, since they essential could become the future of transportation.

Keywords: Autonomous · Vehicle · Blockchain · Technology
Mobility · Services

1 Introduction

Nowadays, technological advances are influencing the way we travel every day. The rising costs of transportation and the environmental damages, led to the creation of new means of transportation such as the Autonomous Vehicles. In the next few years, it is expected that owning an autonomous vehicle will be the norm for consumers, although fully autonomous vehicles are likely to be too expensive for individual ownership. Autonomous vehicles (AVs) offer a unique solution to many of the current issues in transportation, as they represent a technological leap forward that could influence how individuals view mobility [1]. Blockchain is another newly established technology and its main purpose is to facilitate secure online transactions. Together Autonomous vehicles and Blockchain technology could provide the end user with cleaner, more

E. G. Nathanail and I. D. Karakikes (Eds.): CSUM 2018, AISC 879, pp. 797–803, 2019.
https://doi.org/10.1007/978-3-030-02305-8_96

economical and efficient transportation. In this paper, the possibility of using the autonomous vehicles with the contribution of Blockchain technology as part of a service is examined.

2 Literature Review

2.1 Autonomous Vehicles

The concept of driverless vehicles was first attempted in the early 1920s and was later acknowledged in the 1980s when the automated highway systems were developed [2]. This paved the way for semiautonomous and autonomous vehicles to be connected to the highway infrastructure. The first pilots of Autonomous Vehicles were largely made in Germany and the U.S. during 1980 to 2000 [3], but it was Google's driverless car that introduced the term to the public and arose the publicity of Autonomous Vehicles.

The vehicles that can be driven without a human driver are commonly called Driverless or even Autonomous Vehicles (AVs), as it is considered the most popular term. The level of automation can vary from zero to full automation according to the international Society of Automotive Engineers (SAE) that has classified vehicle automation in six automation levels [4]. It is noted that in September 2016, the National Highway Traffic Safety Administration (NHTSA) discarded its own formal classification system released in 2013 and adopted the SAE standard. In SAE's autonomy level definitions, "driving mode" means "a type of driving scenario with characteristic dynamic driving task requirements and the automation levels are categorized as: No-Automation (Level 0), Drive Assistance (Level 1), Partial Automation (Level 2), Conditional Automation (Level 3), High Automation (Level 4), Full Automation (Level 5). The last level is describing Fully Autonomous Vehicles, where an Automated Driving System (ADS) on the vehicle can do all the driving in all circumstances, while the human occupants are just passengers and need never be involved in driving. Fully Autonomous Vehicles (Level 5) are expected to make travelling safer, cheaper as well as more comfortable and more sustainable [5]. The general use of AVs in every day travel will lead to the reduction of the generalized costs of travel and the use of AVs will open car travel to children, elderly and the disabled [5].

Even though the idea of driverless vehicles has been around for decades, the large costs have delayed large-scale production [5]. Due to the great competition among car manufacturers, the year 2020 has been slated as a horizon year to offer commercial AVs to the general market [5]. Based on the deployment and adoption of previous smart vehicle technologies, such as automatic transmission and hybrid electric drive [6] the forecast is that AVs are expected to constitute around 50% of vehicle sales, 30% of vehicles, and 40% of all vehicle travel by 2040 [7]. Thus, it is essential to understand the challenges and the opportunities that lie ahead if all those assumptions are to become true, taking as a fact that autonomous vehicles will revolutionize transportation.

2.2 Blockchain Technology and Applications

Blockchain is a shared digital ledger encompassing a list of connected blocks stored on a decentralized distributed network that is secured through cryptography. Each block contains encrypted information and hashed pointers to a previous block, thus it is difficult to retroactively alter a block without modifying the entire chain and the replicas within the peer network. New blocks are validated by peers on the network, providing credibility and preventing malicious activity and policy violations. Cryptography and membership functions provide easy data sharing between parties without privacy breach and tampering of records. All confirmed transactions are time stamped to provide full record provenance [8].

The last few years, Blockchain technology has gained widespread traction and is constantly attracting new investments. A wide range of industries, including finance, insurance, healthcare, logistics and supply chain management are starting to discuss and test Blockchain technology in a number of use cases [9]. Blockchain enables a potentially evolving and open set of parties to maintain a safe, permanent, and tamper-proof digital ledger of transactions, without a central authority. The main asset of this technology is that transactions are not recorded centrally, each party maintains a copy of the ledger and a majority of parties need to verify a new transaction before it can be recorded in the ledger. Once a transaction is approved, it is practically not possible to modify it or cancel it. Therefore, Blockchain technology can be seen as a replicated append-only transactional data store, and it can be used as a substitute for centralized registers maintained by single trusted authorities [10]. Blockchain technology is considered to be among the most disruptive technologies across several industries. One of the key advantages of blockchain is that it is much more secure than traditional IT solutions. In addition, blockchain-based applications have the potential to revolutionize several sectors.

3 Problem Statement

It is largely believed that Autonomous Vehicles will mainly attract those without current access to private transportation or those, who were previously unwilling or unable to drive a private car [3], but the main question is how these Vehicles will be obtained by the end-user. Due to the large cost of a privately owned Autonomous Vehicle, the main most likely scenario is that they will be publicly owned and they will be shared as an alternative use of transportation. The concept of Shared Autonomous Vehicles combines elements of conventional carsharing and taxi services with AVs [5]. These shared vehicles could provide inexpensive and convenient mobility-on demand services [11], which have been described as driverless taxis [5], while providing the end user the most convenient route based on real-time traffic information. But this situation raises the problem of the safe and secure payment for the services provided.

This problem could be rectified by blockchain's digital encryption and distributed consensus algorithms. This plays a key role in promoting trusted communication and cooperation among vehicles, road-side devices, and pedestrians that use smart phones in a decentralized autonomous transportation system, since there could be the risk of

successfully spending the digital currency more than once. The Blockchain technology consists of a distributed data verification mechanism that guarantees a traceable blockchain ledger that can protect against the double spending without trusted central authorities in a completely decentralized fashion, thus facilitating point-to-point money transfer or digital asset exchange without intermediaries.

4 AVs and Blockchain Combination System

In this paper, in order to resolve the issues that can arise from the use of Autonomous Vehicles, we propose a system that combines blockchain technology effectively to support the communication and the transaction between the vehicle and the end user (Fig. 1). To avoid any profit making from the private sector companies, this system will be publicly owned and will be considered as an alternative form of public transportation, thus increasing the users' choices for transportation.

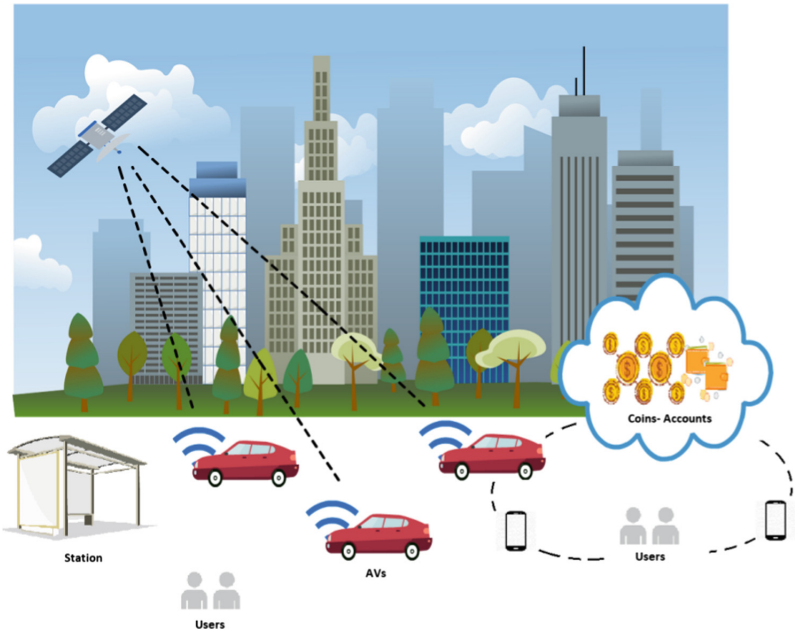

Fig. 1. AVs and blockchain combination.

It is noted that in all EU countries the number of taxis ranges from 1.3 to 2 per 1,000 inhabitants. The indicator chosen for Greece is clearly higher than the European average (2.5 taxis per 1,000 citizens for Athens, 2 taxis per 1,000 citizens for the rest of Greece). Indicatively, in Rome the ration between taxis and citizens is 2.1 taxis per 1000 citizen and in Brussels the ratio is 1.5 taxis per 1000 citizen. Based on the 2 taxis per 1,000 citizens ratio that is mainly used in Greece, we consider using the same ratio

for the number of autonomous vehicles included in our system. Thus, in a city such as Patras with a population approximately 160000 citizens, an average number of 320 Autonomous Vehicles would be used. This will be a system with shared AVs, where they will be placed in their suitable designed stations throughout the city, where the user will be able to collect them.

In order for the system to work in a suitable environment, a specialized mobile application must be created. In the application the location of the stations that the AVs can be collected must be provided, as well as the location of the Vehicles themselves. The Autonomous Vehicles would be able to present all their necessary information in this mobile app, therefore making every ride safer for the end user. Furthermore, the application must be user friendly for all ages and it should be accessible to all end users. The users themselves should make a personalized account in this application and they should provide all their necessary information. Moreover, through the application they would be able to create "coin accounts" using blockchain ledgers, thus making their payment transaction easier once they finish their trip. The vehicle itself must be able to recognize "coin accounts" using blockchain ledgers and confirm the transaction. Once the trip and the payment are complete, the AV should be able to return to its allocated station or even pick up a new costumer through the application. Once the transaction between users and AVs are complete, the AV should be able to use the blockchain ledgers that it collected in order to facilitate other needs that may arise, such as paying a parking space in the city center, if there is no station available, or even charging for an electrical AV. In this system AVs and Blockchain technology could work together through the use of a Smartphone application in order to provide an alternative form of transportation.

5 Rising Concerns

Autonomous vehicles and Blockchain Technology offer a wide range of benefits, in terms of safety, efficiency, environmental impacts, and increased mobility, but they could also have diverse impacts. The use of Autonomous Vehicles while reducing or even eliminating driver errors, it does not necessarily eliminate vehicle, road or environmental factors, or other road users from contributing to crashes. Neither can we be certain that computer-based control will be sufficiently safe and reliable [12]. Moreover, another issue that may arise is the responsible "person" in case of an accident. The question that needs to be answered is in case that a driverless crashes, who will be guilty and who should compensate for the damage.

Furthermore, a particular issue created by the advanced automated vehicle control is the ethical tradeoffs, such as "The social dilemma of autonomous vehicles" [13]. For example, consider the dilemma of a driver approaching a group of pedestrians crossing the road immediately in front of him or her. The vehicle is design to opt for the utilitarian design option; namely minimizing the number of injuries. However, when people were asked if they would purchase a vehicle programmed to minimize total injuries versus a vehicle programmed to protect its occupants at all costs, they generally preferred the self-protective option. To summarize, we all want to increase overall

safety, but we think that our own safety precedes all others', thus making a challenging the use of an Autonomous Vehicle with this characteristic.

In addition, when it comes to new technology such as AVs and blockchain, privacy concerns are accounted for. There is the belief that Autonomous Vehicles would function using information regarding the users' location (private home or office address) as well as their personal information, thus creating major privacy issues. There may be also some security worries in regards of hackers. Hackers may get into the vehicle's software and affect or control its operation, therefore creating a security concern. This is the reason why policymakers will need to modify or enact rules to address and influence these broad concerns, since this technology becomes more widespread, and models become available for consumer use.

6 Conclusions

In this paper, we propose the use of Blockchain technology together with Autonomous Vehicles in a publicly owned system that will be mainly used by those without current access to private transportation or those, who were previously unwilling or unable to drive a private car, such as elderly, disabled and small children. This system will be offer its end safer, cheaper, more comfortable and more sustainable travelling experience through the use of Autonomous Vehicles, while Blockchain will provide the means to a secure payment transaction by facilitating point-to-point money transfer or digital asset exchange without intermediaries.

It is clear there is significant value in the Blockchain being used to verify transactions, avoid fraud, confirm ownership and simplify purchasing processes. But it is important to note that Blockchain does not solve privacy issues, and it is an authenticity solution only. Blockchain technology is excellent for smart contracts, but it is not ideally suited for protecting data. If the data stored on the Blockchain is altered it will be noticeable, however there is no way to neither know what parts of the data have been altered nor retrieve the originals via the Blockchain. This is the reason why applying the blockchain technology to autonomous vehicles could have some value, since it could act as a ledger to validate transactions between a vehicle and a service provider.

To summarize, the combination of Autonomous Vehicles and Blockchain technology has the potential of establishing a secured, trusted a system where the autonomous vehicle will provide the end user the most convenient route based on real-time traffic information, and Blockchain will make the economic transaction easier since it could allow peer-to-peer carsharing and eliminate the need for banks.

References

1. Howard, D., Dai, D.: Public perceptions of self-driving cars: the case of Berkeley, California. In: 93rd Annual Meeting of the Transportation Research Board, Washington, D.C. (2014)
2. Fenton, R.E., Mayhan, R.J.: Automated highway studies at the Ohio state university-an overview. IEEE Trans. Veh. Technol. **40**, 100–113 (1991)

3. Anderson, J.M., Nidhi, K., Stanley, K.D., Sorensen, P., Samaras, C., Oluwatola, O.A.: Autonomous Vehicle Technology: A Guide for Policymakers. Rand Corporation, Santa Monica (2014)
4. NHTSA (2017). https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf
5. Fagnant, D.J., Kockelman, K.: Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. Transp. Res. Part A **77**, 167–181 (2015)
6. Litman T.: Autonomous Vehicle Implementation Predictions. Victoria Transport Policy Institute 28, Victoria (2015)
7. Saeed, A.B., Madjid, T., Mohsen, A., Tracey, O.: Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. J. Mod. Transp. **24**(4), 284–303 (2016)
8. Timothy L.: Blockchain for Transportation: Where the Future Starts, TMW Systems, Inc. A Trimble Company (2017)
9. Christidis, K., Devetsikiotis, M.: Blockchains and smart contracts for the Internet of Things. IEEE Access **4**, 2292–2303 (2016)
10. García-Bañuelos, L., Ponomarev, A., et al.: Optimized execution of business processes on blockchain. arXiv preprint arXiv:1612.03152 (2016)
11. Burns, L.D., Jordan, W.C., Scarborough, B.A.: Transforming Personal Mobility. The Earth Institute, Columbia University, New York (2013)
12. Martens, M., van den Beukel, A.P.: The road to automated driving: dual mode and human factors considerations. In: The 16th International IEEE Annual Conference on Intelligent Transportation Systems (ITSC 2013), The Netherlands, pp. 2262–2267 (2013)
13. Bonnefon, J.F., Shariff, A., Rahwan, I.: The social dilemma of autonomous vehicles. Science **352**, 1573–1576 (2016)