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Vehicular Social Network Using Blockchain Technology

Şükrü Okul[ab1,*], Fatih Keleş[b2], Muhammed Ali Aydın[b3]

[a] *TUBITAK BILGEM, Kocaeli, Turkey*
[b] *Computer Engineering Department, Istanbul University-Cerrahpasa, Istanbul, Turkey*

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ORCID [1] 0000-0001-6645-7933; [2] 0000-0002-9138-6492; [3] 0000-0002-1846-6090

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ABSTRACT

In this study, the application of the vehicle social network, which is formed by integrating the concept of vehicle social network, which started to emerge with the increase in the number of connected vehicles, and the blockchain technology, which is widely used today, is implemented with a decentralized structure with the structure created in this study. In other words, while integrating the vehicle social network and blockchain technology, the system structure in this study is suggested. Within the scope of this proposal, information will be given about some of the improvements made and it is discussed which points have been addressed in the system and what is being worked on. In this context, after mentioning blockchain technology and vehicle social network, the architecture and algorithm in this study will be mentioned. We will use diagrams and pseudocodes to explain our algorithm. Finally, we will summarize what we talked about in this study with the conclusion part.

1. Introduction

Communication between vehicles is an issue that has come to the fore today. One of the most important points in this regard is that these vehicles form a network with the increasing number of connected vehicles. This network is called vehicle social network. Vehicle social networks have many solution methods. The system design in this study is about how to make the vehicle social network applicable using blockchain technology. As it is known, blockchain technology has recently attracted great attention by national and international press, various international organizations, private sector and public institutions, but it is expressed as a potentially more powerful technology than the Internet by some researchers (Sultan, 2018). In the report published by Allied Market Research, it is stated that the blockchain market was $228 million in 2016 and could reach $5.4 billion by 2023(Allied, 2021). From an academic point of view, while it was very difficult to come across a study on blockchain in the literature a short time ago, it is seen that there are many studies on this subject and their number is increasing gradually (Anascavage, 2018). Although there are very few studies on the VSN and Blockchain side, there are many studies on blockchain, especially in the V2V (vehicle to vehicle) field. This shows that the use of blockchain has come to an important point in transactions related to vehicles with high mobility and security.

There is no direct equivalent of our study in the literature. The scope of studies on VSN and Blockchain is different. In this study, a model is proposed based on the different use of existing methods. While vehicle social networks are generally used and implemented with the help of centralized structures, it makes a contribution to the literature in terms of how it is done and implemented with a decentralized structure in our study.

1.1 Blockchain

Unlike most databases used today, Blockchain Networks are not under the control of any person, group or company and do not use the central network system. Thanks to this nature of technology, it is very difficult to change or manipulate a database without consensus among the people who use it (Kinnaird, 2022). With the peer-to-peer network, communication can be directly peer-to-peer and no central authority is needed for new data created, with the distributed ledger system, all participants in the network access the entire database and view the history in the database, errors from the central server can be reduced to zero, with the consensus mechanism, each transaction is verified unanimously by the majority of the participants in the system (Crosby, 2016) (Iansiti, 2017) (Rennock, 2018). Blockchain is a distributed ledger that records and shares transactions within a network. Blockchain technology is built on distributed ledgers on several nodes that are replicated peer-to-peer within the network (Gupta, 2017). Transactions in which information is synchronized with all nodes in a particular network are

**Corresponding author.*
E-mail adresi: sukru.okul@tubitak.gov.tr (Şükrü Okul)

received and sent to others. This method eliminates the need for a trusted third party for transactions. Instead, it provides huge distributed network records where the validity of a transaction is accepted by all participants. Blockchain often uses a consensus-based model to ensure validity, meaning all participants must agree on the transaction. The distributed network does not need a reliable centralized system, as independent participants form a consensus (Dhillon, 2017). Since each block created in the blockchain is interconnected, this technology has been named blockchain (Dounas, 2018). Blockchain is a decentralized distributed ledger technology that reliably allows to create, validates and records digital assets (Wien, 2017). Consensus algorithms are not always used for security. Primitive methods such as Proof of Work can also work.

Blockchain technology is a computational infrastructure with algorithms that create, add and use blocks with information (Zhao, 2016). In a blockchain, All transactions are stored in a ledger and all the participants of the network holds identical copies of this ledger (Lewis, 2017). Blockchain provides security, anonymity and data integrity without the control of transactions by any third party organization (Yli-Huumo, 2016). Blockchain is a storage method in which digital transactions are recorded.

1.2 VANET Technology

VANET is short of Vehicular Ad-hoc Network. The term "ad hoc" found in ad hoc networks means "ad hoc" in Latin and is used to describe a temporary solution to a particular problem. Ad hoc networks also refer to wireless networks, and ad hoc networks have nodes connected via wireless connections. VANET exists as a subclass of MANET in wireless ad hoc networks in three categories of WANET (Wireless Ad-hoc Network) (Jindal, 2016).

MANET (Mobile Ad-hoc Network) is a type of wireless network that establishes the connection between the sender and the receiver without the need for any infrastructure. Considered as the customized version of MANET, VANET technology uses vehicles as mobile nodes. It provides communication between nearby vehicles and between vehicles and roadside units (Liang, 2015).

1.3 Vehicular Social Network

Vehicular social networks are the general name of the concept that deals with vehicles working in a certain routine and incorporating the possible social behaviors of these vehicles into their environment. Vehicular social networks are also referred to as VSN. VSNs, virtual vehicles, RSUs (Roadside Units) combine social networks to communicate based on social characteristics, similar interests, social behaviors and goals on smart devices of drivers, passengers and pedestrians. Social networks and their applications in traffic regarding vehicles are evaluated by the research community and it has been shown that social information obtained through the interaction of participants with each other can help improve the performance of existing mobile communication systems. It is hypothesized in some studies that the social behavior of network entities can be exploited for various applications (Xia, 2015) (Mezghani, 2014) (Vegni, 2015).

At the same time, Vehicular Social Networks are characterized as a general concept used to combine relevant features and conceptual expressions from VANETs and other social networks associated with vehicles. While VANETs form and provide data from a centralized infrastructure, the unified underlying network infrastructure, other relevant social networks contribute to the social knowledge of other entities in the social network. VSNs are not ad-hoc networks, even if the mobility of a particular node is limited by routes as in VANET. VSN can be deployed in a centralized or distributed manner. Unlike traditional networks, VSNs are heterogeneous communication systems in which multiple devices, including embedded devices, RSUs, and smart devices, leverage social behavior to communicate in virtual communities along pathways (Rahim, 2017).

Human factors that cannot be ignored in the vehicle environment play a vital role in the realization of VSNs. For example, vehicle activity and traffic conditions during morning and evening rush hours show relatively high density and static behavior. In such scenarios, vehicles can be connected to create social groups based on social relationships, interests, and user preferences, or to share information individually. Furthermore, vehicle mobility exhibits social features that can significantly improve the performance of communication protocols design in VSNs (Cunha, 2014).

In summary, it is a mobile communication system consisting of a combination of VSN, VANET and social networks (Smaldone, 2008). Nodes in the network share their data and communicate with each other by making use of social interdependencies. Unlike other socially conscious networks, network entities in VSNs are heterogeneous. Considering different situations such as urban and highway, VSNs can be easily deployed in a centralized, distributed or hybrid form, resulting in three different types of communication relationships: human-to-human, human-to-machine and machine-to-machine (Rahim, 2017).

2. System Design

First of all, it is assumed that the vehicles have the necessary infrastructure for verification and communication processes in our system. It is accepted that wireless network technologies exist where all vehicles can communicate with each other. In addition, it is assumed that all vehicles have an internet connection in order to access the regional server where the location information of all vehicles included in the system is located. Thus, it is assumed that there is a public key infrastructure provider to create, issue and valide the public and private keys to ensure the authenticity.

Our general system architecture is shown in Figure 1. There are 5 nodes that make up the consortium. A vehicle is added to our system with a request to join a system from any of them. The information of the added vehicle is also shared with others. A public and a private key are created for each vehicle added to the system. These keys are sent as a response to the vehicle along with the result of the addition.

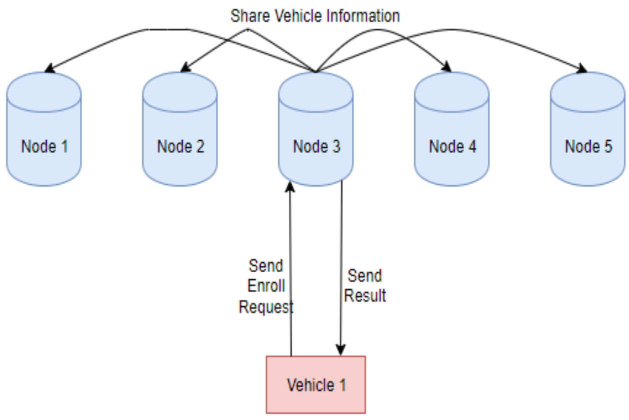

Figure 1. System Design For Authentication to System For A Vehicle

As seen in Figure 2, The location information of the vehicles added to the system is sent to the node closest to the vehicle every second. The sent location information comes in encrypted form and is verified using the sender hash information and the previous hash information. For the verification process, the closest node also sends this information to other nodes. As soon as 3 out of 5 nodes approve, the location is verified. If the location information is verified, it is added to the blockchain.

The structure we mentioned above is our general structure. If a vehicle wants to send a message to another vehicle outside the coverage area in the system, the flow in Figure 3 is applied. First, the vehicles in the system are listed and a vehicle is selected. It is checked whether a network can be established between the vehicle and the selected vehicle over the coverage areas of other vehicles. If a network cannot be established, you are informed that a network cannot be established. If the network can be established, the message is sent.

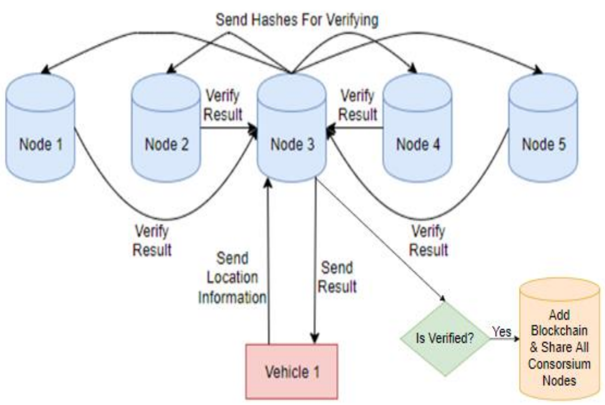

Figure 2. Add Location Information To Blockchain

In order for the above-mentioned structure to be realized, the instant location information is updated and stored in the blockchain where the vehicles are recorded. In this way, the last location information of a vehicle's registration is included in the blockchain. The information in the block includes the information in Figure 4. The sender vehicle hash information included in this information is the sender information. Receiver vehicle id refers to the vehicle that is out of range and selected to communicate from the list. At the same time, the time information (timestamp) and the current location of the sending vehicle are sent. Since all vehicles instantly send their location information to the blockchain consorsium nodes, the location information of the receiving vehicle can be obtained using the receiver vehicle id. At the same time, the sender information and the privateKey information are obtained on the consorsium nodes. Then the encrypted location information sent can be decoded.

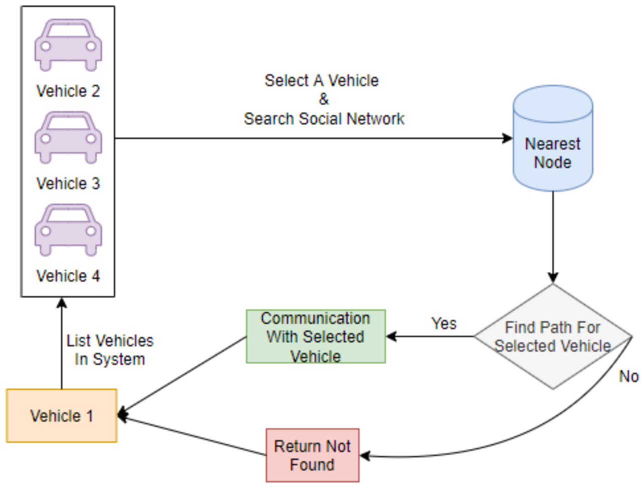

Figure 3. Design For Create Vehicular Social Network For Communication

In addition, the pseudo code of the algorithm that add the location information by finding the vehicle in the blockchain with the incoming location information is given below.

addLocation(senderHash, locationInfo, privateKey)
block = searchBlock(senderHash);
locationText = decodeWithKey(privateKey, locationInfo);
addBlockLocation(block, locationInfo);

Blockchain basically keeps the location information of vehicles. To find the final position of a vehicle, a decision is made by looking at the farthest block of the chain for a vehicle.

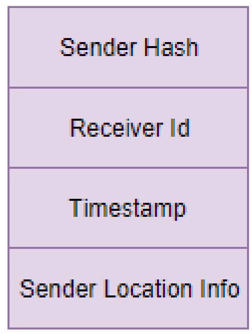

Figure 4. Information Of Social Network Request

3. Conclusion

As a result, in this study, it is aimed to use the blockchain technology by integrating the vehicular social network. With the structure we applied in the study, the vehicular social network was realized without a central structure. The most important sine qua non in this vehicle social network is that they have an internet connection and they have any means for wireless communication. In future studies, the performance of these operations, which we did not focus on in this study, will be emphasized and their performances will be compared with the algorithms used in this study.

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