Vehicle Overspeed Management System Using Blockchain-Assisted IoV: A Survey

Subhajit Mallick, Shounak Bose, Ghanashyam Nandi,
Prof. Manju Biswas & Dr. Sourav Banerjee

Kalyani Government Engineering College, Kalyani, Nadia

Abstract **-** The Internet of Vehicles (IoV) is a network of vehicles integrated with sensors, software, and intermediary technologies to connect and exchange data over the Internet according to predetermined standards. Traditional vehicular ad-hoc networks (VANET) have evolved into the Internet of Vehicles as a result of recent significant breakthroughs in the new but promising paradigm of the Internet of Things (IoT) and its fusion with cutting-edge wireless communication technology. In India, traffic accidents are a big cause of concern. The leading cause of death on Indian roadways is overspeeding. According to data from recent years, speeding contributes to roughly 60% of traffic accidents. We must eventually transition to the Internet of Vehicles to solve this problem and many others related to road safety. With the help of the internet of vehicles, driving will significantly change. Due to the development of smart city infrastructure and its communication with our automobiles through the IoV, it will be safer than ever. This is where Blockchain is crucial. Blockchain secures the entire process of sharing information among IoVs and adds features like traceability. Because of Blockchain, we can be confident that the system is secure and reliable. This paper highlights the problem that road transport in India is very unsafe, and we put forward a proposed model of Blockchain-assisted IoV as a solution to tackle this issue.

Keywords **-** Internet of Vehicles (IoV); Internet of Things (IoT); VANET; Blockchain; Vehicle Overspeeding; Traffic Management;

1. Introduction

The Internet of Vehicles (IoV) is a network of vehicles that are fitted with sensors, software, and intermediary technologies to connect and exchange data over the Internet by predetermined standards. The Internet of Automobiles (IoV), which originated from Vehicular Ad Hoc Networks (also known as "VANET," a type of mobile ad hoc network intended for communication between vehicles and roadside equipment), is anticipated to develop into an "Internet of Autonomous Vehicles" in the future. IoV is anticipated to be one of Future Mobility's ACES (Autonomous, Connected, Electric, And Shared) enablers.

As a product category, road cars rely on a wide range of technological fields, including real-time analytics, inexpensive sensors, and embedded systems. The IoV ecosystem depends on contemporary infrastructure and architectures that share the computational load among numerous processing units in a network for these to work together harmoniously. IoV technology is frequently brought up in discussions of smart cities and driverless automobiles in the consumer market. Many of these architectures rely on open-source software & systems to work. For example, Subaru's infotainment platform in its automobiles can detect a driver's wakefulness and sound an alarm to signal a stop for a break [1].

Vehicle-to-vehicle (V2V), vehicle-to-human or personal device (V2H or V2P), vehicle-to-infrastructure (V2I), vehicle-to-roadside unit or other similar Infrastructure (V2I or V2R), and vehicle-to-sensors are the five primary types of connections needed inside the IoV infrastructure (V2S).

Connected vehicles use IEEE Wireless Access in Vehicular Environments for V2V and V2I communication (WAVE). Wi-Fi and 4G/5G are mostly used by V2I pairs, MOST/Wi-Fi is used by V2S pairs, and Bluetooth, NFC, CarPlay, and CarPlay or Android Auto are used by V2H pairings.

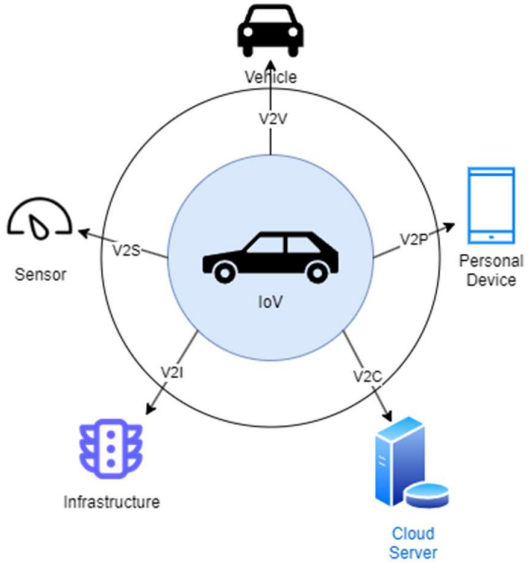

Fig 1. Basic Architecture of IoV

The Internet of Vehicles is set to fundamentally transform the driving experience. Implementing smart city infrastructure and communicating with our vehicles through the IoV will make it safer than ever. Here are some of the applications that make it very important to the automotive industry [2].

i. Accident Avoidance
ii. Traffic control
iii. Theft avoidance
iv. Improved Road Safety
v. Faster Travel And Convenience
vi. Emergency response
vii. Environmental Benefits

A blockchain is a machine for storing statistics in a manner that makes machine changes, hacking, and dishonesty hard or impossible. A community of computer structures referred to as a blockchain simply copies and disseminates a virtual log of transactions throughout the complete community. Each participant's ledger gets a reproduction of each new transaction that takes place on the blockchain, and every block in the chain carries numerous transactions. The term "allotted ledger technology" describes a decentralized database ruled by many users (DLT) [3].

Implementing blockchain technology in the Internet of Vehicles (IoV) explores its applicability as a security solution in VANET. Particularly, it proposes the use of blockchain for vehicle identification and data authentication. In the context of this paper, vehicle identification is a mechanism by which a vehicle identifies another vehicle (i.e. vehicle registration number, plate number, etc.) and data

authentication is a data verification process where only those authorized receivers would be able to decode or unpack the message [4].

The Blockchain is the ideal solution to store and retrieve protected data because it can act as a distributed, single source of shared truth. It has the potential to replace all other systems of records as the main one. The management of facilities, including work order tracking, preventative maintenance, and life cycle assessments, can be changed by blockchain.

Applications for asset digitization, HVAC system operations documenting property transfers, tenant occupancy of cubicles, and security access are the most common in the facility management sector. Blockchain can assist in controlling IoT-connected objects and smart buildings that use solar or other renewable energy sources [5].

Due to the decrease or removal of those unpleasant manual tasks, Blockchain will expedite processes and reduce expenses. Almost any process, such as space management, work orders, environmental health and safety planning, and preventative maintenance, might be modified using this [6].

2. Literature Review

Jawaher Abdulwahab et all [7] discussed the Internet of Things is driving a technological revolution. IoT increases the number of connected objects, such as vehicles our lives simpler, safer, and more intelligent thanks to the Internet. IoT objects being mounted on wheels have produced new technology. the Internet of Automobiles (IoV). The IoV has finally been put into practice thanks to the enormous advancements in computer and communication concepts. The IoV is a more sophisticated form of VANET that is primarily intended to promote safe driving. Although there are more and more vehicles connected to the IoT, there are still many unknown IoV issues and potential. The problems of implementing and deploying IoV in urban cities were identified and categorized in this work by looking at several research studies on the topic. The limits of IoV technology are also described in this paper. Additionally, several current and potential remedies that address the highlighted problems were briefly covered.

Mirador Labrador et all [4] discussed It is anticipated that vehicle connectivity, or the Internet of Vehicles (IoV), will be the answer to the urgent problem of traffic, enabling a better traffic management system, and decreasing traffic accidents. However, one aspect of this that will guarantee its implementation is vehicular communication. However, the ongoing concerns about security and privacy should not exclude vehicular communication. To ensure accurate vehicle identification and data verification when data packets are transported from one vehicle to another, this study suggests a mechanism for using blockchain technology. The simulation of urban mobility (SUMO) and the Objective Modular Network Testbed in C++ (OMNET++) are used in the study, together with a specially built application and an OMNET++-integrated cryptography method. According to the findings, the Internet of Vehicles can leverage blockchain as a security mechanism for data verification and vehicle identification.

Tej Tharang Dandala et all [3] discussed the Internet of Things (loT) as a global network that connects all intelligent items. It is how aU devices are made able to communicate with one another. The term "Internet of Cars" is used when the smart devices connected via the internet are limited to only vehicles (lol). Vehicle ownership has been rising exponentially as a result of cities' burgeoning populations and ongoing urbanization. As a result, traffic management has grown to be a major issue in modern society. This paper offers a 10 V-based traffic management strategy to address the issue that plagues us regularly.

Léo Mendiboure et all [8] discussed_IoV represents the future of vehicle networks by introducing intelligence to the driving environment. A novel architecture called SD-IoV that integrates SDN technology has been proposed to enhance IoV network management, resource usage, and QoS. However, this architecture creates fresh dangers, and security in particular is a significant obstacle. The lack of authentication and authorization of the applications (network, third party, or user) at the distributed SD-IoV control layer is one of the key security flaws. There are currently no restrictions on how these applications can affect SDN controllers and, by extension, network behavior. As a result, any program that is malicious or infiltrated can disrupt the entire network. This research suggests a novel trust-establishing system based on blockchain technology as a result. This system intends to handle network resource allocation, application behavior, application identification, and application identity. Using the distributed nature of the SD-IoV, the concepts of application identity and application trust index are introduced. Additionally, a design for this system that makes use of smart contracts is also provided.

Chao Wang et all discussed [9] With a Peer-to-Peer system called Bitcoin, blockchain technology has transformed the world of cryptocurrencies. By capturing immutable transactions, it can offer a distributed, transparent, and extremely private database. Currently, the method is receiving a lot of study attention in other fields, such as the Internet of Vehicles (IoVs). Blockchain technology is used to create a decentralized and secure vehicular environment to address some centralized issues and enhance IoV architecture. With this study, we hope to build a thorough examination of blockchain's uses in the IoV. The blockchain and IoVs are introduced at the outset of this paper. Also covered are several recent surveys on blockchain-enabled IoVs. Additionally, the integration of blockchain technology with IoVs is examined from seven angles to explain how the blockchain is used in IoVs. Finally, the directions for future integration-related research are addressed.

Dr. Anil Kumar Sagar et [10] all discussed the internet of vehicles is projected to play a crucial role in the development of the next generation of intelligent transportation systems. By 2020, up to 75% of automobiles globally will have connectivity. By 2020, the expansion of the internet of vehicles will generate revenues of about 2.94 billion USD. Real-time vehicle data, improving the rate of on-time delivery, decreasing fuel costs and labor, traffic management, and accident tackling are some of the significant applications that need to be tackled if IOV is to reach its full potential. The ultimate objective is to make transportation more effective, environmentally friendly, and secure. The notion of the internet of vehicles and its architecture is first introduced in the paper that is being presented. As we get into the second section of the article, we offer several applications and solutions to address the issues that the IoV area faces. We talk about the problems with the IoV application and its potential future towards the end.

Taher M. Ghazal et all [11] discussed the increased number of different sorts of cars in the modern world has resulted in a significant traffic rate on the highways. It increased the risk to the patient's health by delaying emergency vehicles. An efficient health autonomous system in medical items has been proposed using Internet of Vehicles-based artificial neural networks (IoV-ANN). The proposed IoV-ANN offers a safe network to watch over and track the movement of the vehicle using GPS. It comprises a self-contained system with an artificial neural network (ANN). Three layers make up the ANN model. IoV sensors are used in the first layers to collect data. The sensor data is processed by second or hidden layers, which also forecast traffic conditions and reroute the emergency vehicle to a precise route. In this article, IoV-ANN contributes to easing traffic congestion to improve the prompt operation of an emergency vehicle. The traffic congestion networks are categorized by ANN. Congestion causes automatic changes to traffic limitations, such as the queue gap in traffic signals and alternative routes. It enables the government to create concepts for detours to improve traffic management. The output layer autonomously issues directives to the driver. The proposed method's simulation analysis demonstrated that the system could function on its own. In comparison to other widely used techniques, the IoV-ANN achieves the highest performance rate of (97.89%), with lower

error rates (9.12%), traffic congestion rates (10.31%), travel times (32 s), vehicle detection rates (93.61%), classification accuracy (95.02%), MAPE (8.4%), and throughput rates (93.50%).

Lyes Khoukhi et all [12] discussed innovative technologies and solutions incorporated into "smart cities" to manage municipal resources like transportation, electricity, and other crucial infrastructure. The most recent advancement in transportation technology is called the Internet of Vehicles (IoV). IoV develops a network of information exchange between automobiles, roadside infrastructure, and surrounding ecosystems. It does this through wireless communication and sensor technology. The present traffic conditions of a smart city, such as traffic accidents, traffic jams, and delays in public transportation, are reflected in many types of data collected from moving objects in real-time.

Junhua Wang et all [13] discussed the Internet of Vehicles (IoV) has been regarded as a crucial technology for establishing Intelligent Transportation Systems in smart cities and is one of the most promising applications in the future Internet of Things. The introduction of sixth-generation (6G) communications technologies will result in large network infrastructures being densely distributed and an exponential rise in the number of network nodes, which will consume an astronomically high amount of energy. In the 6G era, there has been an increase in interest in developing the green IoV for sustainable vehicle communication and networking. The energy cost in an IoV system includes communication and calculation energy in addition to the fuel consumption and electricity costs of moving cars, though, as a particular mobile ad hoc network. Additionally, the energy efficiency optimization of the entire system will be made more difficult by the energy harvesting technology, which is likely to be widely employed in 6G systems. Modern energy-efficient techniques and the impact of the development of 6G networks on green IoV are not extensively discussed in current research, which concentrates only on a portion of the energy challenges in IoV systems. In this article, we provide the key points for managing energy harvesting, communication, computation, traffic, and electric vehicles (EVs) from five different scenarios. When it comes to resource allocation, workload scheduling, routing design, traffic control, charging management, energy harvesting and sharing, and other issues impacting energy efficiency, the literature that is pertinent to each of the scenarios is compared (e.g., resource limitation, channel state, network topology, traffic condition). We also discuss potential difficulties and cutting-edge 6G technology for creating green IoV systems. Finally, we go over current research directions for developing IoV systems that are energy-efficient.

Min Wang et all [14] discussed IoV as the use of internet of things technology in an intelligent transportation system that has caught the attention of both domestic and international research institutions. This paper analyses and discusses the research goals of IoV: communication between vehicles, communication between vehicles and the road, communication between vehicles and people, and communication between vehicles and equipment. It introduces the fundamental idea of IoV along with the specific application scenarios and actual characteristics of the internet of vehicles. The application services that you can offer and the issues with the development are then studied about various technical issues that have arisen throughout the development of IoV. IoV technology is complex and requires more investigation.

3. Proposed Work

3.1 Problem Statement - A lot of road accidents happen in India, daily. According to the data from 2021 published by NCRB, Overspeeding is responsible for 58.7% of all accidents, while reckless or careless driving and overtaking accounted for 25.7%. Over-speeding constituted the paramount traffic rule violation associated with accident-related deaths (69.3%) and injuries (73.4%). From all this data it is clear that overspeeding is a real problem and a major cause for concern. Road safety needs to reduce overspeeding-related accidents in the interest of human life and property.

High-speed vehicles will have a bigger impact during collisions and cause more injuries. Driving faster reduces one's capacity to assess forthcoming events, which leads to errors in judgment and ultimately to crashes. Simply put, an overspeeding vehicle gives other forthcoming vehicles very less time to react and it becomes extremely difficult to avoid a collision. This is how accidents happen due to overspeeding.

3.2 Proposed Solution - Making nearby vehicles aware of overspeeding and reckless vehicles will be a huge step forward in terms of avoiding these accidents. Other vehicles can then take precautionary actions and this can make the difference between life and death. This is especially true for long expressways and sharp turns. At sharp turns, and on long highways in foggy weather, it becomes impossible to know when an overspeeding vehicle may be coming close. In such situations alerting nearby vehicles of a possible danger can be immensely beneficial. Also, if the nearby infrastructures or checkpoints can be made aware of such vehicles, catching the rogue driver and stopping the vehicle at such checkpoint will be easier. And only then can further action be taken and a possible accident could be prevented.

The solution to this and many other road safety issues is to eventually move towards the Internet of Vehicles (IoV). This means gradually replacing the existing vehicles with you. The driving experience will undergo a significant transformation thanks to the internet of vehicles. It will be safer than ever owing to the development of smart city infrastructure and its connectivity with our vehicles through the IoV.

Now the information that is shared by the IoV needs to be secured and trustworthy. This is where Blockchain comes in. Blockchain makes the whole process of sharing the location of the overspeeding vehicle secure and with added features like traceability. Because of Blockchain, we can rest assured that the system is tamper-proof and reliable.

Let's assume that a vehicle is overspeeding and/or recklessly driving. We aim to notify and alert other vehicles nearby about the presence of a rogue vehicle so that they can be more aware of the situation and avoid any possible accident or actively take necessary steps to be on the safer side such as making sure that they have seat belts tied on, or slowing down their vehicle, or stopping the vehicle completely. We also want to make sure that the overspeeding vehicle is caught as soon as possible, thus we also aim to notify nearby checkpoints or Toll Naka where the vehicle can be caught and further legal and precautionary actions can be taken.

Our proposed model for dealing with overspeeding vehicles using Blockchain assisted IoV can be primarily divided into three sections:

- Detecting a vehicle is overspeeding
- Making entries into the public ledger with information about the overspeeding vehicle.
- Alert mechanism, that works with the help of smart contracts of Blockchain.

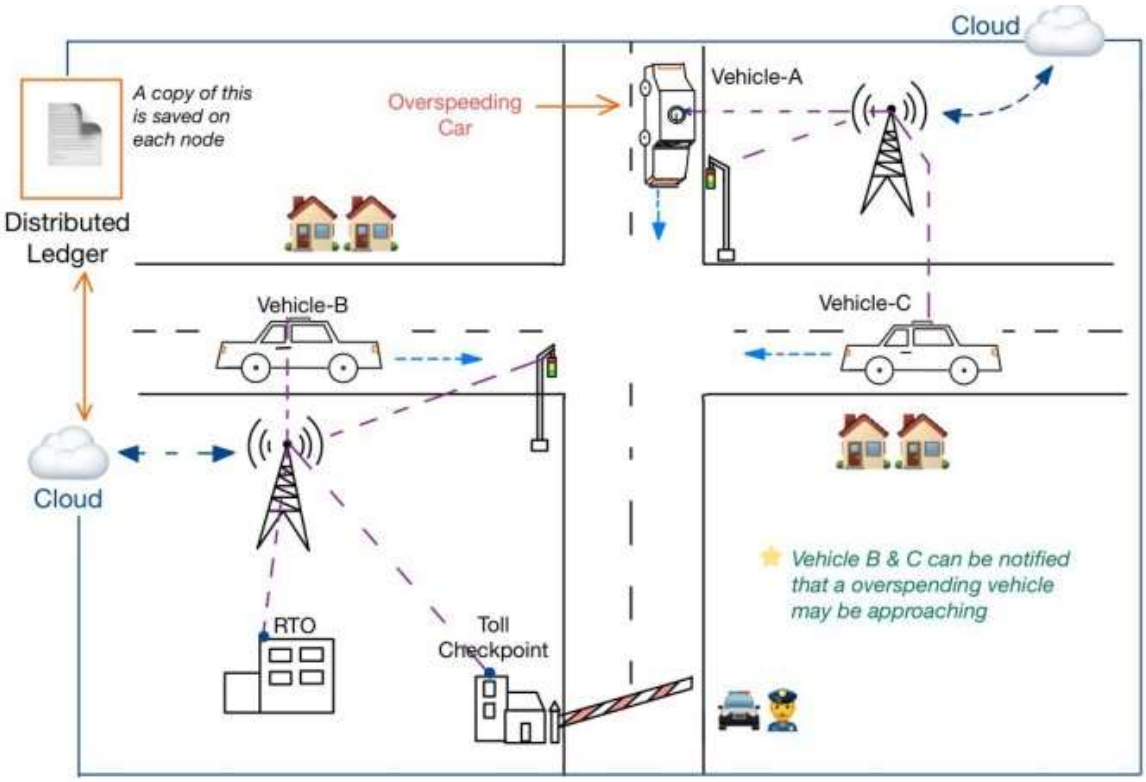

Fig 2: Diagram showing the working of the proposed model

3.3 Detection **-** The process of this alert and stopping of overspeeding starts with actually detecting an overspeeding vehicle. For this, we can use the speedometer sensor reading of the vehicle or the GPS of the vehicle to detect movement speed or a combination of both for increased reliability. This means that every IoV needs to have a GPS sensor on board. The speedometer is already present on vehicles, we just need to process this data by the software onboard on the IoV. If the speed is above a particular threshold of safe speed then the system will flag this vehicle as overspeeding and entries about this vehicle will be made to the public ledger using Blockchain.

3.4 Sharing Information/Making Entries **-** Now, if we detect that a particular vehicle is overspeeding and/or reckless driving (here Vehicle-A), this information will be further processed for the alert mechanism to work. This complete transaction of essential information about the over-speeding vehicle will happen through Blockchain.

The information about the overspeeding vehicle will be uploaded in the form of a block. This information may contain identification info about the vehicle such as the registration number, and also the latitude & longitudinal information to locate the vehicle and alert nearby vehicles based on this location. Now, as per the fundamental features of Blockchain, this block of data uploaded works like a public ledger, where any node can access/view the information and can verify the authenticity of the data. This is how the information is shared. This data is immutable and traceable along with all other features that come with exchanging information through Blockchain. Also, this ledger is distributed, i.e, a copy of this ledger is made available to all the nodes participating in this transaction. Thus adding more layers to its security.

3.5 Alert Mechanism - The alert mechanism is done automatically through the smart contract. This is yet another feature of Blockchain. This works based on the logic that if a new block of data is added to the Blockchain, nodes that are essentially IoVs, that are within a particular radius (let's take that to be 500 meters) get the alert that an overspeeding vehicle may be approaching. So, in the above diagram, Vehicle-B and Vehicle-C would be alerted about the existence of the overspeeding vehicle, Vehicle-A in the nearby vicinity. This alert location & zone can be calculated by the latitude and longitudinal value of the overspeeding vehicle. The smart contract contains this piece of logic and thus this executes automatically according to the terms of the agreement between the IoVs. We also aim to inform the traffic infrastructure or administrative infrastructure such as the nearest checkpoints (or Toll Nakas), in the same way about the overspeeding vehicle so that they can be caught and stopped from causing further harm. After the vehicle is caught, further legal and precautionary actions can be taken.

3.6 Flowchart - The algorithm of this complete process from detection of an overspeeding vehicle to alert system and eventually catching the overspeeding vehicle is represented in the form of a flowchart given as follows:

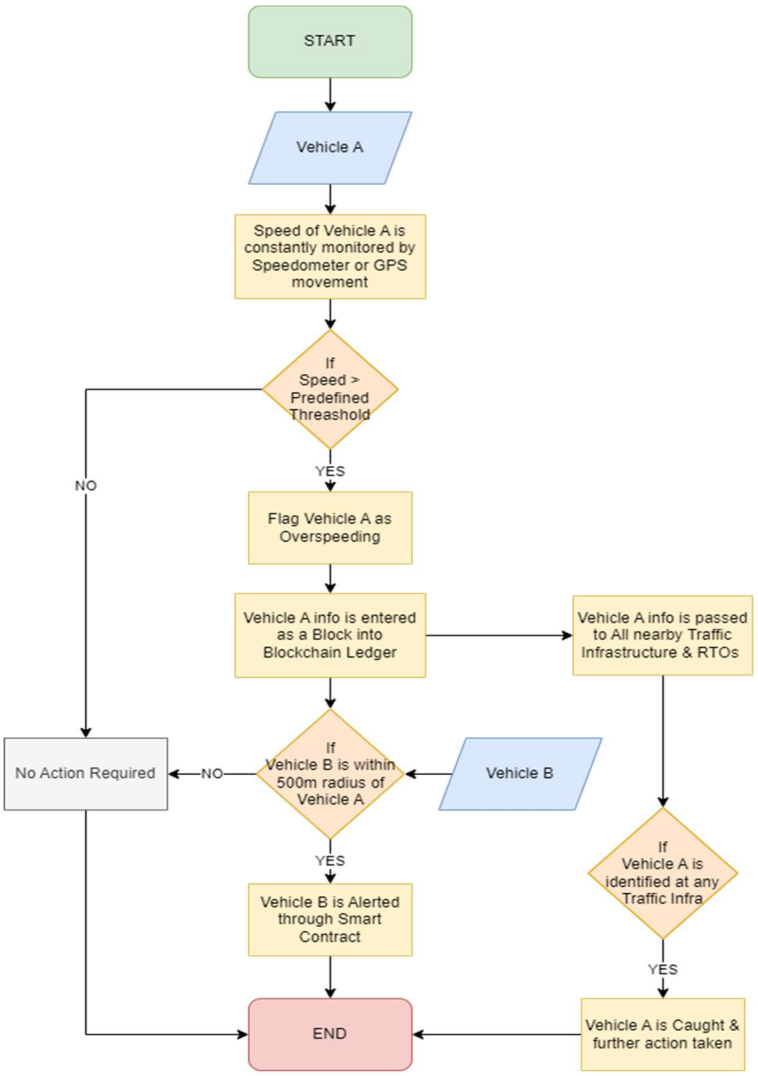

Fig 3: Flowchart showing the complete working process of the proposed mode

3.7 Blockchain Node Network For Proposed Model - The Nodes are the core of the Blockchain structure. The Nodes participate in the Blockchain network and thus validate the data transactions that happen on the network. This is what makes the Blockchain Network decentralized and secure. The Node network for our proposed model is as follows:

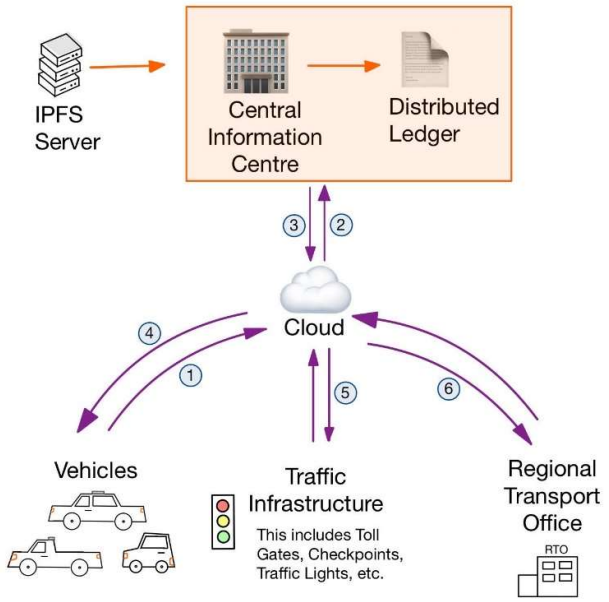

Fig 4: Node Network of Proposed model

The Nodes in this proposed model are:
- Vehicles (IoV)
- Traffic Infrastructure
- Regional Transport Office

These Nodes in the proposed model are all essential parts of the Blockchain. The Blockchain by virtue act as a distributed ledger, thus the same information is synchronized across most of the nodes, i.e, most nodes get a copy of the same ledger. However, all the Nodes do not need to keep a copy of all the transactions, such as the Vehicle Node. These nodes are termed Light Nodes according to Blockchain terminology. When a Block is added to the Blockchain, all the Nodes can access that Block of data through the cloud. Interplanetary file system (IPFS) is the file-sharing protocol that uses peer-to-peer networks to facilitate media file transfer in distributed systems. Here, IPFS servers are used to store large data files and the Blockchain contains only the logs of the transactions. The distributed ledger, i.e, the Blockchain is accessible from each node in the cloud through the Central Information Centre. Each Block of the Blockchain contains the essential data required for the identification and alert mechanism to work. Each Block also contains the previous hash, thus forming the chain of Block, i.e, Blockchain.

When a vehicle over speeds, it logs the data using RSUs through the cloud into the Central Information Centre, as denoted by the directional arrows 1 & 2. The Central Information Centre verifies and processes the data to determine that the vehicle is indeed speeding and then sends data back to other vehicles for the alert mechanism to work, as denoted by arrows 3 & 4. The data is also

sent back to nearby Infrastructures such as Checkpoint and then eventually RTOs to take necessary action based on this. This is denoted by arrows 5 & 6.

3.8 Novelty Of Proposed Work - The Internet of Vehicles is a huge field. It is a network of vehicles connected to the Internet for the efficient sharing of information. Our proposed model deals with a very specific aspect of this whole ecosystem which is over-speeding. Over-speeding is a major hurdle in the way of better road transport. We are proposing an efficient and robust mechanism for dealing with this issue. We came up with using Blockchain for the information exchange for its security and traceability. We believe that shortly we will see advancements in terms of automation in vehicles and thus the day is not far when the Internet of Vehicles will be a reality and a common vehicle feature. Also since the inception of Blockchain, the whole Web ecosystem is slowly shifting towards a more decentralized approach. Thus we are proposing Blockchain as the underline technology that will support this IoV ecosystem. This combination of Blockchain with IoV has hardly been researched before, especially to deal with the over-speeding vehicle. We hope to gain some valuable insights from all the research for model building for the cause we are trying to develop.

4. Conclusion and Future Scope

The Internet of Vehicles (IoV) is designed to make road transport a lot better. It will be safer than ever owing to the development of smart city infrastructure and its connectivity with our vehicles through the IoV. Even in this generation of vehicles, we have cruise control, automatic gear switch, and many features that automate the driving experience. This implies that we are eventually moving towards a driverless, autonomous future where vehicles will be self-driven.

However, we are not there yet and we need several breakthroughs to achieve such limits, especially in the context of Indian roads. Thus, what we believe is that the near future is leaning more towards a mixed form of driving, i.e, it will not be completely driverless, but AI will assist drivers in every aspect of driving, to make road transport robust and one of the safest transports. This is the reason, AI will not have the authority or control to automatically stop the overspeeding vehicle, shortly for which timeline we are proposing this model solution. Thus our model aims to only alert the nearby vehicles because of our assumption that AI will not be given administrative and hardware level control of a vehicle. This is because AI needs to be more failsafe and tamperproof to be given autonomy at that level, and huge developments in this direction need to be done before such things begin to become reality.

Vehicle to Vehicle and Vehicle to Infrastructure will be done through Blockchain. This is simply because of the security it provides. It is immutable, distributed, and traceable which will probably be a standard shortly when Web3.0 will is predominant. Thus communication at such levels where people's lives are dependent should be done through the most secure channel available.

In the future scope, we hope to include more authentication services such as Pollution Under Control Certificate (PUCC) verification and other IoV-related communications through Blockchain.

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