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Applications of Internet of Vehicle(IoV): A Survey

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Abstract

Due to the fast advancement in the field of communication and computation technology, the Internet of Vehicle (IoV) attracts most of the researchers to contribute in this area of research. In the recent research on the Internet of Vehicle (IoV) technology, IoV becomes one of the major active and famous research areas in the technology of networks, especially in transportation. It provides an Intelligent Transportation System (ITS)and it resolves traffic and driving problems by using advanced communication and information technology. Inthe implementation of IoV, the different actuators, sensors, personal gadgets are required so that the vehicles communicate with each other. In this paper, it will provide the comprehensive survey on applications of IoV and also discuss in detail IoVnetwork model, the required technologies for the creation of IoV, the various applications which are based on existing technologies and the features of research in IoV area and Vehicular Sensor Network (VSN's) based effective and security-oriented applications. The key objective of these applications is to reduce fuel consumption and furthermore to provide a supportin saving the life of drivers andpedestrians.

Keywords: Internet of Vehicle (IoV), Vehicular Sensor Network (VSN), Sensor, Network Model.

1. INTRODUCTION

As per the recent forecasting in 2020, approximately, billions of things are going to be associated with the network in which vehicles can take a major part. Nowadays as the number of vehicles isincreased that are connectedg withthe internet of things, traditional VANET are changing into the IoV. VANET connects the vehicles with each other's through the mobile nodes or wireless router and increases the network range [1]. VANET has mobility constraints because it covers a very small mobile network and less connected vehicles. There are some aspects of cities, like tall buildings, traffic jam, structures, unpleasant behavior of drivers, and complicated roads networks, moreover,

hinder use. Hence in VANET, things are involved in short-term, temporary, and unreliable. Customers are not facilitated by whole applications and services from VANET. There is no new implementation of VANET over the few past years. In recent research, most of the researchers are working on IoV, on the other side commercial interest in VANET has not seen yet [2]. In the comparison of VANET and IoV, two main technologies come under consideration i.e. Vehicles Intelligence, Vehicles Networking. Vehicles intelligence is acombination of drivers and vehicles. IoV emphasizes on the intelligent union of vehicles, humans, things, and environments. IoV provides services and a huge network even for large cities. IoV is an open and coordinated framework with controlled and validity with different clients, various vehicles, numerous things, and different systems. With this definition, VANETis just a subsystem of IoV [3].Also, IoV interconnects individuals inside and around vehicles, smart frameworks locally available vehicles, and diverse computerized physical structures in urban conditions, by consolidating vehicles, sensors, and mobile phones into an overall framework, in this way engaging distinctive organizations to be passed on to vehicles and individuals on board and around vehicles. A couple of analysts have alluded to the vehicle as a watch out for PC with four wheels or a watched out for the colossal phone in IoV. These days, in the road network vehicular sensor network, provides a variety of services, for example, driving security, and efficiency. Mobile internet creates a new network if any of the vehicles lost their signal and cut off from the network shown in Figure1.

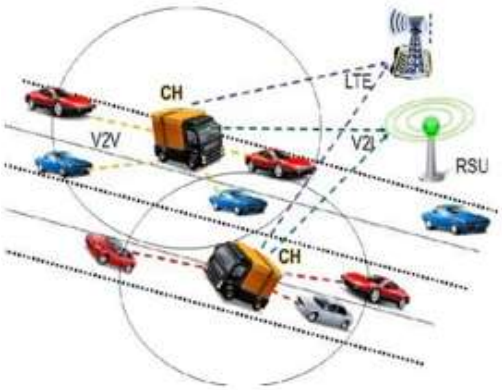

Figure 1: Vehicle connected network [1]

VSNs as shown in Figure 2 has turned into a prevalent research territory for an assortment of administrations in the RoadSide Unit (RSU), for example, the driving security and efficiency. Vehicles expect a fundamental part in checking road surfaces to perceive deterrents and road risks, and their movement is performed by aggregation of various, identification sensors, obstruction development sensors and, impediment distinguishing proof [4-5]. These days, Vehicular Sensor Networks (VSNs) has turned into a prevalent research region for an assortment of administrations in the RSU, for example, driving security and efficiency. Vehicles assume a crucial part in checking street surfaces to distinguish deterrents and street risks, and their observing is performed by an accumulation of different movement sensors (e.g., meter, whirligig, and magnetometer), recognition sensors[6].

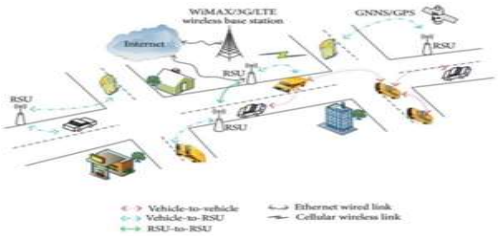

Figure 2: Vehicular Sensor Networks (VSNs) [2]

The basic architecture of IoV is described in section 2 and section 3 describes the IoV applications with a detaileddescription. The section 4 concludes the paper and the future direction of IoV is mentioned in section 5.

2. BASIC ARCHITECTURE OF INTERNET of VEHICLE (IoV)

There are currently different perceptions of IoV due to which there is no outline designed for IoV. A couple of investigators propose the plan of the Internet of Vehicle considering the Internet of Things, which is similar to IoV and includes sensing layer, network layer, and application layer. IoV is simply not just giving the benefit of vehicle-to-vehicle correspondence or vehicle terminals, is likewise gives extra complex frameworks that has the component of human-vehicle-conditionimmovably coordinate collaboration and exceedingly capable headway. IoV is required for supporting cognitive analysis, data figuring which needs novel prerequisites on engineering and help limit with respect to IoV. To accomplish this objective, it facilitates the plans of IoV [7] and detail of four layers is given below:

1. Application Layer
2. Coordinated Computing Control Layer
3. Vehicle Network Environment Sensing and Control Layer
4. Transport and Network Layer

2.1 Application Layer

This layer should support the business model along with services and it should be in an open state. It contains open and close services. The closed one specifically based on the industrial applications whereas open service is based on open applications including real-life traffic service which is being provided by the Internet Service Provider. The third party also got benefit from the open services[8].

2.2 Coordinate Computing Control Layer

This layer provides help to the applications of IoV the wideability of coordinate registering and control for human-vehicle- condition, for example, information preparing, asset portion, and swarm insight processing [1].

2.3 Vehicle Network Environment Sensing and Control Layer

The IoV services depend upon the recognition of the environment sensing of vehicles. It includes vehicle information, services that are available to the vehicle, traffic control of the vehicle. All these things depend on and it implements the services and operations. Vehicles sense condition data around by autopilot traffic stick gathering applications, and sensor applications for accomplishing assistant driving. As far as condition, this layer considers the methodology to screen and concentrate on different dynamic data of humans, vehicles, and conditions through detecting technology. Also, it centers around the technique to get and execute coordinate control guidelines and after that result in agreeable control [9]. The environmental model of IoV is shown in Figure 3 and the natural model depicts correspondences outside the vehicle, engaging joint efforts among

different vehicles, systems, and frameworks. The two models coordinate to give a course of action of administrations that improves security, comfort by utilizing V2V, V&R, V&P devices, and R&P contraption communications with the vehicle[10].

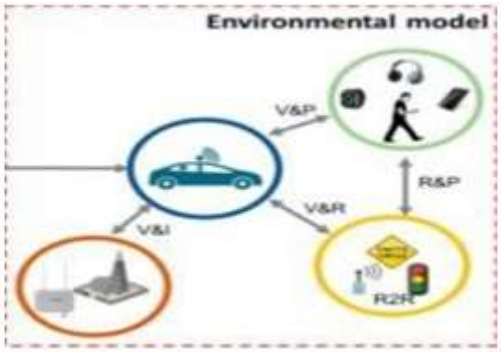

Figure 3: Environmental Model [5]

2.4 Transport and Network Layer

The basic limit of this layer is to comprehend the framework get to focus, the examination of data information, information investigation, and information transmission. Meanwhile, it can similarly comprehend the remote checking and center administration inside the IoV. This layer is comprehending the among affiliation and information trade, which fuses the entrance of the system, the transmission, and control sort out. The system model of IoVhas appeared as Figure 4IoV arrange display needs a multi-level joint exertion show that thinks about the sensor, phones, getting to focuses, Wi-Fi, drivers, people on foot, mobiles, different gadgets, Bluetooth and numerous more to consolidate singular contraptions, vehicles, progressions and nature through the environmental model or intra-vehicle model[11].

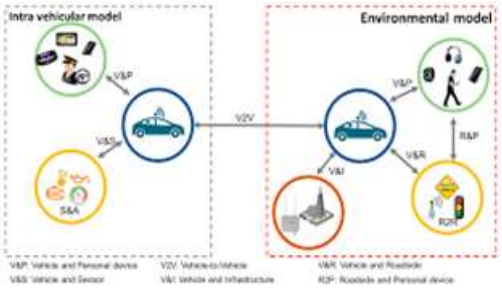

Figure 4: Network Model of IoV [5]

3. APPLICATIONS OF INTERNET OF VEHICLE

An intelligent and automated vehicle is presented with the quick improvement of network and information technology. This produces a lot of applications to provides service with safe driving. For instance, Car Play by Apple, in vehicles at first presented as iOS-based application, which provides music service, complete online map, and turn-by-turn navigate the route, telephone, iMessage. Google Android Auto gives a redirection free interface that grants drivers utilize the service in the vehicle, Like Car Play by Apple.

The content and social functions can be generated by the Chinese launched application for navigation. This describes the driving efficiency and safety application on the Internet of Vehicle network. These applications usecloud-based servers as shown in Figure 5 with the help of network connection it includes:

Figure 5: Cloud in IoV [2]

1. User Applications
2. Safety Applications
3. Safety and Management Oriented Applications

4. Business Oriented Applications
5. Convenience Oriented Applications
6. Productivity IoV Applications

3.1 User Applications

User Applications are that applications that provide some user beneficial services and Safety applications are those applications that enhance the safety and security of vehicles [12]. User applications provide user beneficial services. It provides online or offline services correspondences including video calls, forecasting, and internet service, for example, Road Side Services (RSS) applications, games, music, web browsing, data transferring, location. It provides a basic two user-relatedservices.

- **Local Services:** These applications are concentrating on infotainment that can be expanded from neighborhood-based administrations, for instance, other downloading, notices, nearby electronic business.
- **Global Services:** These services are fixed on data that can be obtained from the overall worldwide Internet [13].

3.2 Safety Applications

The main purpose of technology is to make sure the travelers and vehicular safety and one of the essential applications is crash avoidance. These days, crash avoidance advancements are rising to a great extent. Vehicle-based structures offered by unique gear creators as independent bundles that exhaustively serve two capacities, driver help and impact cautioning. Precisely, affect forewarning fuses sees about a chain auto collision, sees about road conditions, for instance, tricky road, and pushing toward emergency vehicle advised [14]. From one perspective, affect notification could be used to alert automobiles of a mischance that happened advance along the road, in like manner hence introducing a heap up from happening. From one viewpoint, they additionally give early cautioning to the drivers and diminish the odds of a mishap. The keen intersection point, where such standard development control contraptions as stop signs and movement signals are ousted, has been a hot district of research for late years. Vehicles encourage their advancement over the intersection point through a mix of in corporated dispersed constant basic leadership, using GPS, remote correspondences and in-vehicle detecting and computation. Various answers for crash evasion of numerous vehicles at a convergence have been proposed. The intelligent crossing point provides the benefits of efficiency, safety and reliability and comfort. Coordination of vehicles through crossing points leads to the improvement in travel time fuel efficiency and traffic flow[15].

3.3 Safety and Management Oriented Applications

Intelligent Transportation System (ITS) are further distributed into four levels.

a) Safety Oriented
b) Diagnostic System
c) Navigation(GPS)
d) Remote Telematics

a) Safety Oriented:

Intelligent Transportation System (ITS) applications related to vehicle safety are Machine to Machine (M2M) communication-based. By emerging the cloud-based smart servers the quality and performance of an operation can be enhanced to a significant level. On the Internet of Vehicles (IoV), big traffic data utilizes by the server to take intelligent decisions [16]. Driving quality and the performance of drivers improve by these applications. On wheels these automatic operations can be emerged by this application and qualitative driving effort can be reduced. VANET has improved the ITS by using the safety and non-safety applications and improve the traffic efficiency [22], but there are still various challenges and IoV improves the existing issues of VANETs and is a better alternative for existing transportation system [23]. The dynamic nature of VANET technology and the dynamic behavior of attackers need more improvement in the security protocols for secure communication between vehicles network [24].The applications of traffic safety are given below:

- **Automatic Speed Control:** By exchanging the real-time information between the vehicles, it prevents the vehicles from accidents. It performs automatic functions like steering control, speed control, distance from other vehicles, changing of lane, etc. This system is most suitable on the motorway or in cities where roads are wide. In the case of a critical situation, it provides safety[2].
- **Alert Call:** This is an alert call for vehicles, and it is facilitating us in terms of manual or automatic. In case of emergency, it helps to contact the Police, Ambulance, Fire brigade, family, friends, etc. The condition of vehicle information is provided by the call. It informs about the number of Travelers, location, speed, direction, lane, problem, emergency[17].

b) Diagnostic System: For vehicles, this type of application acts as a health consultant [18]. In this type of application, data is monitored through the cloud. This data is further used for the prediction and management of the vehicles. It reduces the maintenance cost of the vehicle. Diagnostic application is as below:

c) Repairing system: It helps the user to resolve the hardware and software issues of the vehicle. It has a cloud-based database system. Whenever the technology move towards the advancement databases fixes itself in it. Through the video and audio technology, all vehicles contain clear guidance. Vehicle ownership cast can be reduced by this application [19].

d) Navigation (GPS): An Intelligent Transportation System (ITS) application related to the navigation is location-based applications. Accuracy of location is the base for the performance of the applications. The data is acquired from the GPS connected to the vehicles. The smooth stream of activity and least carbon outflow in conditions are a portion of the key goals of area-based navigation applications [20].

- **Traffic Information in real time:** It gives us real time the traffic information with the support of video sensors of vehicles. It is also based on heterogeneous communication network system. The current picture analysis could be efficiently supplanted.

- **Parking Facility:** It communicates with already parked vehicles to find out the nearest space for the parking of vehicles. It tells us about the appropriate positioning space of the vehicle. It uses GPS to measure the appropriate space for the parking. It reduces the overhead of fuel consumption and the time which is being spent in finding the space forthe parking. This system is most helpful in the cities[21].

- **Multi Transportation Model:** It enhances the assets indicated by the selection of the user, includes comfort, cash, fuel, time, etc. Route planning service is also provided by the system. In the cities, this application is one of the most innovative applications. This is because of the distinctive methods of inter and intra-city transportation accessibility [21].

e) Remote Telematics:

Exceptionally secure applications of remote usage become conceivable with the help of remotely accessing non-driving applications of vehicles. The applications depend on precise, authentication, remote following techniques. The applications improve the simplicity of utilization of and vehicle monitoring. It includes locking and unlocking of the car through remote, car observation.

3.3 Business Oriented Client Applications

Internet of Vehicle (IoV) business oriented Intelligent Transportation System (ITS) applications are given below: -

a) Insurance
b) Car Sharing
c) Infotainment
d) Others

a) Insurance: There are diverse models for giving insurance based on Intelligent Transportation System (ITS) applications. The models depend on some factual examination of data including the use of vehicles, driving conduct, place of use and time of utilization [13]. The insurance application is as below:

- Driving Statistics Insurance: This gathers the statistical information and calculates the insurance fee on its own. The system is based on cloud vehicle statistics. The data it gathers is based on a daily/monthly/yearly basis like how you drive? How many times did you drive? How many rules of traffic are being violated by you? All this procedure ultimately reduce your cost of insurance.

b) Car Sharing: The concept of improvement in the utilization of resources during driving on the car is being used in the ITS application car sharing. It minimizes the cost of transposition. When we use a car in the form of a group, it can achieve this car-sharing benefits. Car sharing application is as follows:

Car Pooling: This is a cloud-based car sharing application for vehicles. It assigns car service searchers to car proprietor. The passengers whose criteria match, the car will assign to them. The criteria are gender, workplace, employment criteria, age, address, timing etc. The services providers verify the registered service seeker and the owner of the car in this application.

c) Infotainment: The idea behind the infotainment on Intelligent Transportation System (ITS) applications is before they connect home and offices and now, they must connect the drives. For this purpose, strong internet connectivity is important. The application would improve efficiency and travel understanding. This application involves:

- **Connected Autos:** It is a cloud-based auto-connecting application for vehicles. The application relies upon remote sign in into different sorts of online frameworks with security estimations. Because of the utilization of programmed applications for auto drivers on the Internet of Vehicles(IoV), it improves the profitability of driving time duration.

d) Others: Some different applications don't fall into the previously mentioned classifications. In traffic services, these applications are extremely helpful as far as commercialization. These applications depend on various business ideas and advances. Others application is as follows:

Cloud Service: The cloud framework applications shape a free billow of social occasions of vehicles or partners the vehicles to customary cloud computing. Regardless, the advantages of related vehicles are available for use as cloud advantage and the vehicles can utilize keen cloud organizations. It could open new plans of activity in the related drive.

3.4 Convenience Oriented Applications

This application deals with the management of traffic to enhance traffic efficiency. This convenience can lead to satisfaction of drivers. This application classifies many services [9].

- Route Diversions: By using this term different router and planning services available if road congestion occurs.
- Availability of Parking: People face many problems regarding parking. A notification panel is created to overcome this problem. This notification panel gives information about parking in many countries and sectors.
- Enable the Prediction: For the prediction purpose, it anticipates the circumstance of the road. It optimizes the fuel and its usage. The fuel usage control can trigger before starting and ending of the ride.
- Electronic Collection of Toll: The section of payment can do with the use of the electronic fee. Collection of toll payment is specified by electronically. This toll point of collection shall read the on-board units to measure the toll collection. In this electronic device, a built-in meter is fitted you weigh how far the

vehicle travels using the map. That could be very beneficial both for drivers and toll operators.

3.5. Productivity Internet of Vehicle Applications

This application is the additional one with the top form. Productive use can classify as many sub-applications[9].

- Utilization of Time: When the traveler finished their ride after this traveler can easily download the email and read on-board units of the system. While traveling if they stuck into the traffic using time utilization scratch, they can see their selves if the traffic gets blocked.
- Saving of Fuel: This could be very beneficial forboth toll operator and driver because when the system collects the toll payment in the toll booths without stopping then approximately 3% of the fuel could save.
- Environment Benefit: This acquires real-time transportation information and its environmentally relevant data. By applying a multi-approach, this setup works in between vehicle-to-vehicle.

4. CONCLUSION

Internet of the Vehicle (IoV) becomes a major dynamic and famous research area in the technology of networks related to transport. The IoV is a powerful development in the IoT field and it is changing the transportation framework into an overall heterogeneous vehicular system. This concept is based on 'Connected Drive' through smart vehicles. The IoV gives various advantages including dynamic data administrations, with expanded efficiency because of lessened movement clogs and car crashes. This paper focuses on the applications of IoV for safety and efficiency and discusses in detail the basic architecture of IoV, applications of IoV in a different perspective, network model and environmental model. The applications based on safety, effectiveness, productivity, commercialization will help vehicular application and technology developers. These applications help future in technology development and advancement. The future goal of this technology is discussed in this paper which helps the reader to get the idea of future advancement in IoV over VANET.

5. FUTURE WORK

The IoV future is bright as it incorporates the latest technology. The IoV would acquire the novel highlights as each field of the vehicle e from the assembly to the manufacturing uses cutting edge technology. Some future aspects are given below [3]:

- Online Vehicle: The detailed history of the manufacturing to the usage by the customer will be shown online in the future. As well as the vast variety of vehicle services will be accessible on the internet online. These services incorporate the yearly investigation report by the experts, tool tax payment status, vehicular status, history, and many more services. The service cost of the vehicle would be radically lessened.
- Internet Global ID: To show that the vehicle is online or not every vehicle is assigned with the unique id we call it a global internet id. The GPS based ID is begun by different associations

of Govt. for upgrading security in public daylight transport. By using global internet id GPS based distinguishing proof would not be needed for each vehicle [3].

- GPS and RFID: Intelligent Transportation System (ITS) operational system will be enhancing the coordination of RFID and GPS. This is because of the chance of new areas for ITS applications and also proficiency and service quality improvement in existing application spaces. RFID provides global id and GPS provides navigation both redefine a much stronger system in collaboration with each other. Route finding helps in data dissemination. This collaboration has an extensive effect on the general execution of ITS applications. Subsequently, it would bring about enhanced client experience and activity administration [3].
- On-Road Internet: Inter-vehicular communication, intra vehicular communication, and vehicular mobile Inter-net are the three main communication components of IoV [23]. Internet access in the vehicle would include new gadgets on the internet in a huge amount. This is because of the consideration of all on-street vehicles. Online security and privacy confide in ID research will be started in this field in future.
- Car Payment: Car payment will be paid through the internet online. Thorough mobile the driver is not be needed to prove their identity again and again. It would be a noteworthy advance regarding the obtaining of monetary personality by vehicles. Traffic management effectiveness is enhanced by the car payment. This would be as far as for issue free toll accumulation, fuel refilling, and even installment for administration and services.
- Data of Big Business: A combination of a vehicular system and different systems in cloud-based would come about as a large information asset. The asset could be used in a profitable way with an extensive variety of organizations including car, Internet, protection and market examination. IoV can handle global information as it involves big data and any delays in processing and analysis of the huge amount of data, real-time collection are intolerable [21].

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