Research Patterns and Trends in Localization of IoVs

Parveen, Rishipal Singh, Sushil Kumar

Abstract: The accurate localization of Internet of Vehicle (IoV) is essential for promoting safety on roads. IoVs are evolving Vehicular Adhoc NETwork (VANETs). The objective is to automate various security aspects and efficiency features in vehicular networks. In this study, we conduct a review of literature and investigate the techniques used for localization of IoVs on roads. This study identifies major issues occurring in localization of IoVs using Global Positioning Systems (GPS). The major challenges are; 1) To achieve high accuracy in localization. 2) To obtain Error free localization of IoVs. 3) Verification of location of IoVs. 4) Security and privacy of vehicle. In order to develop robust IoVs, these issues are to be addressed efficiently. Various researchers have made the contribution by developing numerous algorithms and techniques. This paper reviews the techniques being deployed to overcome the challenges and reports the trends and patterns already set in the field of localization of IoVs. Our paper summarizes the worthy work done by researchers in this field and lays the necessary foundation for the improved implementation of novel and more efficient techniques.

Keywords: Internet of Vehicle (IoV), Vehicular Adhoc NETwork (VANETs), Global Positioning Systems (GPS), localization, smart city, Internet of Things (IoT).

I. INTRODUCTION

The Internet of Vehicles (IoV) has been evolved from the ad-hoc networks comprised of vehicles, which is A New Era of the Internet of Things (IoT) [1]. IoV is a fascinating research area in today's smart networks and intelligent communication systems. IoV is supposed to play a vital role in resolving traffic & road issues by the smart incorporation of intelligent information and communications technology (ICT). Now-a-days, a huge number of cars and vehicles are being driven on roads, and hence resulting in the increased probabilities of fatalities that occur due to accidents.

The interconnection of vehicles running on roads via some smart connecting media like internet is basis to the formation of Internet of vehicles (IoV). IoV can be viewed as the convergence of the mobile internet and IoT. IoV is emerging area from our Automobile industry and inseparable part of smart city life. IoV is comprised of the internet of things and VANET [2]. IoT is a network of devices (as things) communicating with each other to provide smart solutions to our daily life problems. It involves sensing the environment and collect the data. Then, this voluminous data are sent back to the base station for intelligent processing [3]. Another important part of IoVs is Vehicular ad-hoc networks (VANET). VANET is a ad-hoc network, in which the nodes (the 'things') are the vehicles running on the roads. It is specific to the situation for which it is being established due to its ad-hoc nature [4]. The VANET follows a distributed approach for the interconnection of the moving vehicles. VANETs have found very interesting internet of things (IoT) applications like intelligent transportation systems, autonomous driving, and so on. This review has been undertaken to find the answers to the following *three* research questions:

- RQ1. What is the motivation factor behind the localization of IoVs?
- RQ2. What are the various challenges being faced in the accurate localization of IoVs?
- RQ3. What are the various techniques being used by the researchers to identify the research trends and patterns in the field?

The paper comprises of five sections. The following section introduces the architecture and applications of IoVs. Section III describes the Localization of IoVs and the related work in detail. The answers to RQs are explained in Section IV. Section V presents the conclusion and future work.

II. MOTIVATION, ARCHITECTURE AND APPLICATIONS OF INTERNET OF VEHICLES

A. Layered Architecture of IoV

A typical Layered architecture for IoV along with the functionalities of individual layer is shown in Fig 1. The two bottom layers serve as input unit to the system. The top two layers are the output layers of the system. The smart logic is embedded in the middle most layer. The most bottom layer is called Perception layer, as name suggests, it is responsible for the sensory unit to gather the environmental data.

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The next layer is Co-ordination Layer. The middle layer is Artificial Intelligent layer, which connects the bottom two and top two layers. The fourth layer is Application layer which includes the Apps for specific domain of interest. The topmost layer is the Business Layer, which provides Business solutions.

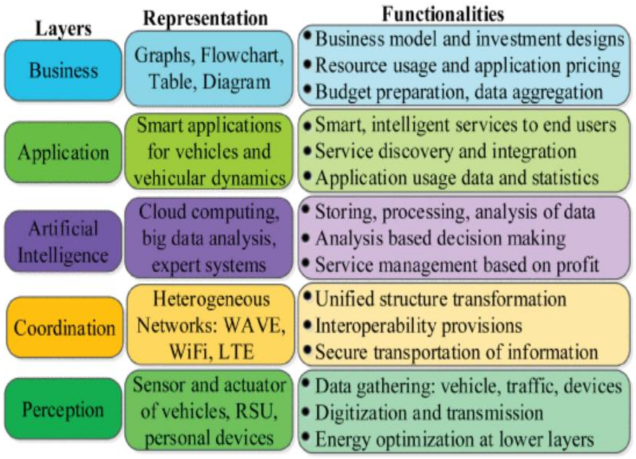

Fig. 1. Layers and their functionalities

B. *Network Model of IoV*

Network model is composed of a swarm model and an individual model as shown in Fig 2.

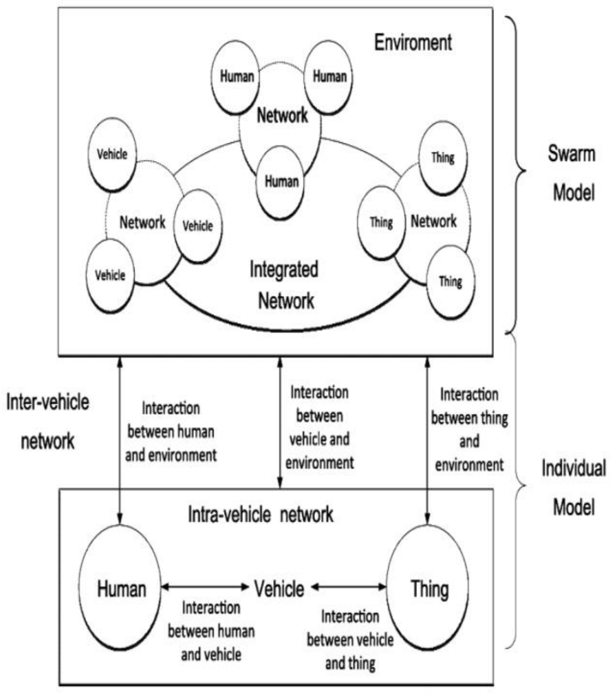

Fig. 2. Architecture of a Typical IoV

C. *Major Applications of IoVs*

The major applications areas of IoVs are discussed as below [5]:

1. *To make the driving Safe*:
   By embedding the sensors in the body of the vehicles to detect any possible collisions and generate the warning signals to avoid collisions.
2. *To control and improve Traffic conditions*: By providing smart maps and traffic control systems.
3. *To generate instantaneous Crash response*: By generating emergency messages with the crash location and directing to the nearby hospitals and PCRs.
4. *To improve the quality of Convenience services*: By providing the ability to remotely access a car; remote door unlocks and stolen vehicle recovery.
5. *To support the Infotainment:* By real time streaming of audio-visual music through dashboards.
   Smart Toll applications, Intelligent "Navigation facility, self-driving vehicles, smart crash prevention, traffic flow monitoring, and vehicle autonomy are other fascinating applications of IoVs.

III. LOCALIZATION OF IOVS AND RELATED WORK

A. *Localizations of IoV [7]*

O. Kaiwartya et al. [6] introduced a localization technique on the basis of geometry. They showed that the proposed technique is useful for industry revolution 4.0 cyber-physical systems. They also marked a challenge in this area that is GPS outage. Also, suggested va solution for the same, Cooperative localization techniques such as GPS-free and GPS-assisted. D K Sheet *et al.* [8] stressed out the verification of the location marked by the localization technique. They stated that the growth rate is high in the vehicular communication and hence, there is an intense increase in the location-based intelligent transport system (ITS) applications. They deployed multiple cryptography based techniques in order to verify and secure the location of vehicles. Monteiro *et al.* [9] worked on the vehicular network and directional antennas. They deployed antennas specifically the directional antennas to develop the information-theoretic location verification system (LVS), to detect malicious nodes.

Balaei [10] revealed the importance of the localization techniques and motivation for localization of the on-the-road vehicles. Like traffic management, smart navigation system and intelligent collision avoidance system etc.

Manuel Fogue [11] proposed efficient algorithms on the neighborhood data collection of vehicles and then smart decision making of nodes (or vehicles) to move forward or in the backward direction to avoid collisions.

B. *Regarding location privacy of Internet of vehicles*

Ying *et al* [13] highlighted another important aspect of localization techniques. They came up to the conclusion that the location privacy is highly sensitive issue since vehicle's location can result in leakage of sensitive information. Dynamic Mix-zone method is proposed for Location Privacy (DMLP) in present study. Ghafoor *et al.* [17] remarked that VANET is wireless ad-hoc network facilitating the intelligent connectivity among vehicles without any fixed infrastructure.

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Huang *et al.* [18] proposed a software-defined pseudonym system (SDPS), where they collaborated the cloud computing concept with the VANETs. They demonstrated that how the integration has enhanced the quality of vehicular information services. SDPS refers to the pseudonym-utilization and improves the location privacy of the vehicles.

Amit *et al*. [23] debated the IoV's features built upon the location-based services by considering the new opened up vulnerabilities that can endanger the security and privacy of vehicles.

George [14] advocated the VANETs to prevent accidents. And, he also demonstrated that these networks cause privacy issues.

Dandal *et al.* [15] proposed more efficient architectures and strategies for road traffic management. They contributed for better monitoring and emergency alert to traffic accidents.

Jun Yao *et al.* [16] described Cooperative positioning techniques for providing more efficient and accurate vehicle location information.

F. Malandrion *et al.* [19] contributed a A-VIP frame work for providing accurate location information of vehicles along with private verification of location.

Salim Bitam *et al*. [29] introduced a new technique namely VANET-Cloud based on cloud services integrated with VANET. It is to provide smart assistance to the drivers of manned vehicles.

F.Akyiliz *et al*. [30] extended the concept of IoVs to the wireless devices and communications. They proposed new models for IoVs made up of various wireless devices only.

Zhengming *et al*. [33] discussed all the long range projects for the IoVs like designing, testing, monitoring the IoVs developed or IoVs applications.

Gongjun *et al*. [34] carried simulation to show the power of cloud services to make the vehicular data clouds. They proposed an architecture based on software technology for carrying the data obtained from the IoV Vehicles via clouds of IoT.

C. Regarding location error in internet of vehicles

Kasana *et al.* [7] offered a location error resilient geographical routing (LER-GR) protocol. To assess the error in location inferred, they used Rayleigh distribution.

Jianqi *et al* [36] presented a rigorous review of position-based routing protocols. They carried out study for urban locations and highway environments. They contributed qualitative analysis of existing techniques.

D. Regarding localization accuracy of internet of vehicles

Tan Yan *et al.* [12] introduced the GPS navigators. Clearly, they demonstrated the benefits and limitations of GPS systems which is widely being used in daily life. The restriction is where there is no satellite coverage, like tunnels, GPS connection gets lost and hence driver becomes insecure.

Jiafu *et al.*[40] proposed a CVCs which are cloud-assisted. Up gradation of VANETs to CVC is based on the advances in mobile cloud computing (MCC), dedicated short range communication and context-aware technology.

Ammoun *et al*. [41] studied and assessed the risk associated with crossing the roads. They utilized the GPS and IVC. An IVC based application is integrating standard 802.11 along with a GPS receiver. The performance of IVC is analyzed using a vehicular application approach. The system evaluates and anticipates risk of collision on a road crossing. Di Wu *et al*. [42]**,** Hao Liet *et al*. [43] and Feliz *et al*. [44] introduced new cooperative algorithms to ensure accuracy in localization of IoV based vehicles. It is a great contribution to the fast and effective IoVs simulations

E. Regarding location verification of Internet of Vehicles

Syed *et al*. [45] studied the Data packets' propagation in a vehicular NDN (VNDN) environment. They made multiple simulations and reached to the conclusions that there is a delay in transmission of data packets using VNDN which is intolerable.

Marco *et al*. [46] proposed a fully distributed cooperative solution to discover and verify neighbor node position in a mobile ad hoc network. This solution helps finding neighbor node position securely.

Vivek *et al*. [47**]** launched a new geographical secure path routing protocol (GSPR). It is free from the infrastructure boundaries. It is tolerant to the disruptions due to the faulty nodes.

Manuel *et al*. [48] verified the position inferred on the basis of the information interchanged among the neighbors. They contributed a proactive but cooperative mechanism for resolution of verification issues.

Leinmuller *et al*. [49] studied the impacts of wrongly inferred position in VANETs. They contributed a framework for the detection and reduction of the impact wrongly inferred positions.

H Fubler *et al*. [50] advocated the usage of VANETs and IoVs for better traffic management and better road safety applications.

IV. MAJOR FINDINGS AND DISCUSSION

VANET is one of the most important proceedings in terms of technology and internet and after observing the present the need of internet of the vehicle. It saves more time, money, life etc. Internet of Vehicles will be very useful in disaster management, military surveillance, spotting various accidents from a remote location where the victim or any other messenger is unable to justify the current situation gives proper information in time. VANET is a Milestone in the field but each field has merits and demerits. IoV is an intelligent in-vehicle sensor with the features to globally position the vehicles along with identifying it globally.

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It is used to determine the location of the vehicle with accuracy, privacy and its verification in VANET with an integration with another emerging technology [32],[35],[37],[38],[39] namely IoT. Table 1 depicts the trends and research patterns in this candidate field. Section 3 answers the all RQs successfully and summarized as below.

TABLE I. TRENDS IN LOCALIZATION OF IOVS

Study	Year	Contribution
Jun Yao *et al.* [16]	2011	Cooperative positioning for vehicular networks
Balaei [10]	2012	Instantaneous lane-level positioning using DSRC
Ghafoor *et al.* [17]	2013	Beaconing approaches in vehicular ad hoc networks
Rehman *et al.* [4]	2013	Challenges in IoVs
Tan Yan *et al.* [12]	2014	Grid-based on-road localization
Yang *et al.* [1]	2014	IoT- future 4.0 revolution
Manuel Fogue [11]	2015	Securing warning message dissemination
D K Sheet *et al.* [8]	2016	Location information verification using transferable belief model
Monteiro *et al.* [9]	2016	Information-theoretic location verification system with directional antennas
Huang *et al.* [18]	2016	Software defined networking with pseudonym systems
Sethi *et al.* [2]	2017	IoV- Motivation and Architecture
Dandal *et al.* [15]	2017	Internet of Vehicles (IoV) for traffic management
Swati *et al.* [3]	2018	Energy-Efficient Routing Using Low-Power Sensors
Kaiwartya O. *et al.* [5]	2018	Challenges and future aspects
O. Kaiwartya *et al.* [6]	2018	Geometry-based Localization for GPS Outage

V. CONCLUSION

Internet of Vehicles (IoV) is continuously unfolding itself as a global VANET. The motivation behind using the IoVs includes the necessarily automation of Vehicles and their security, and privacy. IoV is revolutionizing the entire automobile industry. In today's world, driver-less cars and unmanned vehicles are very fascinating and giving very promising signs for future aspects of IoVs.

The research patterns in localization of IoVs have been identified with this review and the potential research areas are also explored. Numerous algorithms have been proposed for accurate identification of location of the vehicles on the move to provide them perfectly intelligent assistance. All of these techniques have some benefits and some drawbacks. In future, we propose to uncover the hidden problems in the localization of vehicles of IoVs and to resolve them by proposing more promising solutions.

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