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. 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.

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 a 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.
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. Malandrin 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.Akyildiz 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.

Leimuller 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. It is used to determine the location of the vehicle with accuracy, privacy and its verification in
Research Patterns and Trends in Localization of IoVs

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                          |
| Jia et al.[10]                        |
| 2011                                  |
| Cooperative positioning for vehicular networks |
| Balcer[12]                            |
| 2012                                  |
| Instantaneous lane-level positioning using DSRC |
| Ghafoor et al.[17]                    |
| 2013                                  |
| Beaconsing in vehicular ad hoc networks |
| Rahman et al.[4]                      |
| 2013                                  |
| Challenges in IoVs                    |
| Tan et al.[12]                        |
| 2014                                  |
| Grid-based on-road localization       |
| Yang et al.[20]                       |
| 2014                                  |
| IoT - future of revolution            |
| Fogue et al.[11]                      |
| 2015                                  |
| Securing warning message dissemination |
| D K Sheet et al.[5]                   |
| 2016                                  |
| Location information verification using transferable belief model |
| Montani et al.[9]                     |
| 2016                                  |
| Information-theoretic location verification system with directional antennas |
| Hu et al.[18]                         |
| 2016                                  |
| Software defined networking with pseudonym systems |
| Sethi et al.[2]                       |
| 2017                                  |
| IoV - Motivation and Architecture     |
| Dandala et al.[15]                    |
| 2017                                  |
| Internet of Vehicles (IoV) for traffic management |
| Swati et al.[3]                       |
| 2018                                  |
| Energy-Efficient Routing Using Low-Power Sensors |
| Kaivartya et al.[5]                   |
| 2018                                  |
| Challenges and future aspects         |
| O. Kaivartya et al.[6]                |
| 2018                                  |
| Geometry-based Localization for GPS Outeage |

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.

REFERENCES

1. Fangchun, Y., Shangguang, W., Jinglin, L., Zhihan, L., & Qibo, S. An overview of internet of vehicles. China communications, 11(10), pp. 1-15, 2014.
2. Sethi, P., & Sarangi, S. R. Internet of things: architectures, protocols, and Applications. Journal of Electrical and Computer Engineering, 2017.
3. Roy, S. S., Puthal, D., Sharma, S., Mohanty, S. P., & Comnayo, A. Y. Building a Sustainable Internet of Things: Energy-Efficient Routing Using Low-Power Sensors Will Meet the Need. IEEE Consumer Electronics Magazine, 7(2), pp. 42-49, 2018.
4. Rehman, S., Khan, M. A., Zia, T. A., & Zheng, L. (2013). Vehicular Ad-Hoc Networks (VANETs):An Overview and Challenges. Journal of Wireless Networking and Communications, 3(3), pp. 29-38, 2013.
5. Kaivartya, O., Abdullah, A. H., Cao, Y., Atlameen, A., Prasad, M., Lin, C. T., & Liu, X. Internet of vehicles: Motivation, layered architecture, network model, challenges, and future aspects. IEEE Access, 4, pp. 5356-5373, 2016.
6. Kaivartya, O., Cao, Y., Lloret, J., Kumar, S., Aslam, N., Kharel, R. & Shah, R. R. Geometry-based Localization for GPS Outeage in Vehicular Cyber Physical Systems IEEE Transactions on Vehicular Technology. 2018.
7. Kasana, R., Kumar, S., Kaivartya, O., Yan, W., Cao, Y., & Abdullah, A. H. Location error resilient geographical routing for vehicular ad-hoc networks. IET Intelligent Transport Systems, 11(8), pp. 450-458, 2017.
8. Sheet, D. K., Kaivartya, O., Abdullah, A. H., Cao, Y., Hassan, A. N., & Kumar, S. Location information verification using transferable belief model for geographic routing in vehicular ad hoc networks. IET Intelligent Transport Systems, 11(2), pp. 53-60, 2016.
9. Monteiro, M. E. P., Rebelato, J. L., & Souza, R. D. Information-theoretic location verification system with directional antennas for vehicular networks. IEEE Transactions on Intelligent Transportation Systems, 17(1), pp. 93-103, 2016.
10. Alam, N., Balaee, A. T., & Dempster, A. G. An instantaneous lane-level positioning using DSRC carrier frequency offset. IEEE Transactions on Intelligent Transportation Systems, 13(4), pp. 1566-1575, 2012.
11. Fogue, M., Martinez, F. J., Garrido, P., Fiore, M., Chiasserini, C. F., Casetti, M., & Manzoni, P. Securing warning message dissemination in VANETs using cooperative neighbour position verification. IEEE Transactions on Vehicular Technology, 64(6), pp. 2538-2550, 2015.
12. Yan, T., Zhang, W., & Wang, G. A grid-based on-road localization system in VANET with linear error propagation. IEEE Transactions on Wireless Communications, 13(2), pp. 861-875, 2014.
13. Ying, B., Makrakis, D., & Hou, Z. Motivation for protecting selfish vehicles’ location privacy in vehicular networks. IEEE Transactions on Vehicular Technology, 64(12), pp. 5631-5641, 2015.
14. Seuwou, P., Patel, D., & Ubakama, G. Vehicular ad hoc network applications and security: a study into the economic and the legal implications. International Journal of Electronic Security and Digital Forensics, 6(2), pp. 115-129, 2014.
15. Dandala, T. T., Krishnamurthy, V., & Alwan, R. (2017). Internet of Vehicles (IoV) for traffic management. In Computer, Communication and Signal Processing (ICCCSP), 2017 International Conference on pp. 1-4, 2017.
16. Yao, J., Balaee, A. T., Hassan, M., Alam, N., & Dempster, A. G. Improving cooperative positioning for vehicular networks. IEEE Transactions on Vehicular Technology, 60(6), pp. 2810-2823, 2011.
17. Ghafoor, K. Z., Lloret, J., Bakar, K. A., Sadiq, A. S., & Mussa, S. A. B. Beaconing approaches in vehicular ad hoc networks: a survey. Wireless personal communications, 73(3), pp. 885-912, 2013.
18. Huang, X., Yu, R., Kang, J., Wang, N., Maharjan, S., & Zhang, Y. Software defined networking with pseudonym systems for secure vehicular clouds. IEEE Access, 4, pp. 3522-3534, 2016.
19. Malandrino, F., Borgiattino, C., Casetti, M., Chiasserini, C. F., Fiore, M., & Sadao, R. Verification and inference of positions in vehicular ad hoc networks through anonymous beaconing. IEEE Transactions on Vehicular Technology, 66(7), pp. 5641-5653, 2017.
20. Dinesh, D., & Deshmukh, M. Challenges in vehicle ad hoc network (VANET). International Journal of Engineering Technology, Management and Applied Sciences, 2(7), pp. 76-88, 2014.
21. Samara, G., Al-Salihy, W. A., & Sures, R. (2010, September). Security analysis of vehicular ad hoc networks (VANET). In Network Applications Protocols and Services (NETAPPS), 2010 Second International Conference on pp. 55-60, 2010.

22. Kawaiyota, O., Abdullah, A. H., Cao, Y., Altameem, A., Prasad, M., Lin, C. T., & Liu, X. Internet of vehicles: Motivation, layered architecture, network model, challenges, and future aspects. IEEE Access, 4, pp. 5356-5373, 2016.

23. Tyagi, A. K., & Sreenath, N. Location privacy preserving techniques for location based services over road networks. In Communications and Signal Processing (ICCSIP), 2015 International Conference on pp. 1319-1326, 2015.

24. Sun, Y., Song, H., Jara, A. J., & Bie, R. Internet of things and big data analytics for smart and connected communities. IEEE Access, 4, pp.766-773, 2016.

25. Fekri, M. A., Kawar, F., Boussard, M., & Trappenberg, L. The internet of things: the next technological revolution. Computer, 46(2), pp. 24-25, 2013.

26. Hasan, S. F., Ding, X., Siddique, N. H., & Chakraborty S. Measuring disruption in vehicular communications. IEEE Transactions on Vehicular Technology, 60(1), pp.148-159, 2011.

27. Aslam, B., Wang, P., & Zou, C. C. Extension of internet access to VANET via satellite receive–only terminals. International Journal of Ad Hoc and Ubiquitous Computing, 14(3), pp.172-190, 2013.

28. Contreras, J., Zeadally, S., & Guerrero-Ibanez, J. A. Internet of Vehicles: Architecture, Protocols, and Security. IEEE Internet of Things Journal, 2017.

29. Bitam, S., Mellouk, A., & Zeadally, S. VANET-cloud: a generic cloud computing model for vehicular Ad Hoc networks. IEEE Wireless Communications, 22(1), pp.96-102, 2015.

30. Akylidiz, I. F., Mohanty, S., & Xie, J. Ubiquitous mobile communication architecture for next-generation heterogeneous wireless systems. IEEE Communications Magazine, 43(6), pp. S29-S36, 2005.

31. Huang, J. M. Research on internet of vehicles and its application in intelligent transportation. In Applied Mechanics and Materials, Vol. 321, pp. 2818-2821, 2013.

32. Chum, T. W., Yu, S. M., Hui, L. C., & Li, V.O. VSPN: VANET-based secure and privacy-preserving navigation. IEEE Transactions on Computers, 63(2), pp.510-524, 2014.

33. Z. Li, C. Liu, and C. T. Chigan, “VehicleView: A universal system for vehicle performance monitoring and analysis based on VANETs," IEEE Wireless Commun., vol. 19, no. 5, pp. 90–96, 2012.

34. He, W., Yan, G., & Da Xu, L. Developing vehicular data cloud services in the IoT environment. IEEE Transactions on Industrial Informatics, 10(2), pp.1587-1595, 2014.

35. Jerbi, M., Senouci, S. M., Meraihi, R., & Ghamri-Doudane, Y. (2007, June). An improved vehicular ad hoc routing protocol for city environments. In Communications, 2007. IEEE International Conference on pp. 3972-3979, 2007.

36. Liu, J., Wan, J., Wang, Q., Deng, P., Zhou, K., & Qiao, Y. A survey on position-based routing for vehicular ad hoc networks. Telecommunication Systems, 62(1), pp.15-30, 2016.

37. Cao, Y., Wang, T., Kawaiyota, O., Min, G., Ahmad, N., & Abdullah, A. H. An ev charging management system concerning drivers’ trip duration and mobility uncertainty. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2016.

38. Witt, M., & Turau, V. (2006, July). The impact of location errors on geographic routing in sensor networks. In Wireless and Mobile Communications, 2006. ICWMC’06, pp. 76-76, 2006.

39. Oliveira, H. A., Nakamura, E. F., Loureiro, A. A., & Boukerche, A. (2005, November). N Error analysis of localization systems for sensor networks. In Proceedings of the 13th annual ACM international workshop on Geographic information systems (pp. 71-78), 2005.

40. Wan, J., Zhang, D., Zhao, S., Yang, L., & Lloret, J. Context-aware vehicular cyber-physical systems with cloud support: architecture, challenges, and solutions. IEEE Communications Magazine, 52(8), pp. 106-113, 2014.

41. Ammoun, S., Nashashibi, F., & Laureuge, C. Crossroads risk assessment using GPS and inter-vehicle communications. IET Intelligent Transport Systems, 1(2), pp.95-101, 2007.

42. Wu, D., Zhang, Y., Yao, D., & Regan, A. C. Location-based crowdsourcing for vehicular communication in hybrid networks. IEEE transactions on intelligent transportation systems, 14(2), pp.837-846, 2013.

43. Li, H., & Nashashibi, F. Cooperative multi-vehicle localization using split covariance intersection filter. IEEE Intelligent transportation systems magazine, 5(2), pp.33-44, 2013.

44. Kamali, F. K., Mo, Z. H., & Lan, K. C. (2007, March). Rapid generation of realistic mobility models for VANET. In Wireless Communications and Networking Conference, 2007. WCNC 2007. pp. 2506-2511, 2007.

45. Ahmed, S. H., Bouk, S. H., Yaqub, M. A., Kim, D., Song, H., & Lloret, J. CODIE: Controlled data and interest evaluation in vehicular named data networks. IEEE Transactions on Vehicular Technology, 65(6), pp. 3954-3963, 2016.

46. Fiore, M., Casetti, C. E., Chiasserini, C. F., & Papadimitratos, P. Discovery and verification of neighbour positions in mobile ad hoc networks. IEEE Transactions on Mobile Computing, 12(2), pp. 289-303, 2013.

47. Pathak, V., Yao, D., & Iftode, L. (2008, September). Securing location aware services over VANET using geographical secure path routing. In Vehicular Electronics and Safety, ICVES 2008. IEEE International Conference on (pp. 346-353), 2008.

48. Fogue, M., Martinez, F. J., Garrido, P., Fiore, M., Chiasserini, C. F., Casetti, C. & Manzoni, P. Security warning message dissemination in VANETs using cooperative neighbor position verification. IEEE Transactions on Vehicular Technology, 64(6), pp. 2538-2550, 2015.

49. Leinnmüller, T., Schoch, E., & Kargl, F. (2006). Position verification approaches for vehicular ad hoc networks. IEEE Wireless Communications, 13(5).

50. Puchler, H., Mauve, M., Hartenstein, H., Käsemann, M., & Vollmer, D. A comparison of routing strategies for vehicular ad hoc networks, (2002).

Retrieved Number: A111219IS5S0209/2019©BEIESL
DOI: 10.35940/ijeat/A111219IS5S0209

Published By: Blue Eyes Intelligence Engineering & Sciences Publication

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249 – 8958, Volume-9 Issue-1S5, December, 2019