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COMPARISON OF VEHICULAR LOCALIZATION TECHNIQUES WITH RESPECT TO THEIR TECHNICAL ASPECTS

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ABSTRACT*—The VANET is a developed technology nowadays, which provide cost efficient and quick communications in auto- mobile industry and providing safety to drivers with a number of applications. Realtime Information collected from the vehicular nodes based on assumptions from different application and protocols. GPS is the most popular technology installed in vehicles to collect reasonable assumptions.VANETS is totally depends in the localization systems that shows the movements of vehicles in critical areas. There is some undesirable issued faced in GPS systems such as information not being robust or not available for some applications. There are different localization methods are proposed by the researchers such as dead reckoning, cellular localization and image/video localization, to overcome issues of GPS systems. In this paper we discussed the different localization applications and techniques, and the issues for VANET. Further- more, we compare the all localization applications and techniques with respect to their technical aspects.*

Keywords: vehicular ad hoc network (VANET),Global, Positioning, System (GPS),Wireless, Sensor, networks (WSN), Localization, Cellular.

I. INTRODUCTION

Over a last decade vehicular localization has been used in a wide range of application to make vehicles more smarter.VANET used to create an ad-hoc network use moving cars as nodes. Every moving cars works as a node or wireless router, each car connected with other car within the range approximately 100 meters to 300 meters.When a vehicle is out of range then the other nearest vehicle that is in the range of network connected automatically within the network. This technology is also used by the police and fire brigade vehicles to communicate with each other for safety purpose.Vehicle localization plays an important role in VANET to improve localization applications. Vehicle location- estimation plays an important role in the field of VANET and attracted the attention of a lot of applications in recent years. Defense Department of U.S developed GPS technology, which is very useful to resolve the vehicle localization problems, but this solution is unreliable because multipath environment effect the Performance of GPS localization [1]. The main objectives of a VANET system are used to enable competent data distribution for the safety of passengers and drivers also protect them from any mishaps. There are various applications that are used to facilitate the travelers such as, map-location, inter- net access, collision detection, accident detection and driver assistance [2]. Fig 1 Shows the Vehicular AD-HOC Network model. Different localization approaches are used to develop these application [3]. Real time vehicles locations such as lon- gitude. Altitude and latitude are found using these approaches. GPS provides orientation and positioning services using digital compasses and receivers. Furthermore, the distance between the one vehicle and obstacle vehicle nodes are calculated and

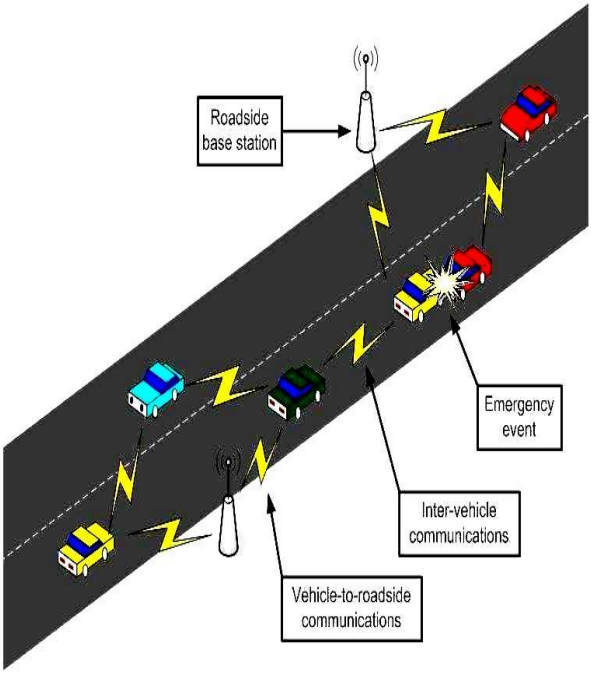

Fig. 1. Vehicular AD-HOC Network .

different researchers, their main focus has been on vehicular localization improvement and accuracy and develop different applications to resolve these issues [3]. Fig.2 shows the number of applications that are specifically conceive for these systems, these applications are already developed and implemented in some of the recently designed vehicles. are helpful to improve the safety and reduce the rear end accidents using the accurate information about the location with the help of sub-meter to direct and calculate the distance between two vehicles[7]. Furthermore, abasic requirement of these applications are accurate location information for safety driving. Clear view of obstacles and other vehicles are provided with the help of vision-enhancement application. These applications are very help full in when vehicles are behind the obstacles and surrounding covers with fog.

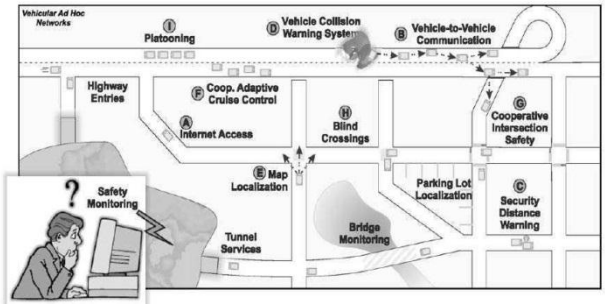

Fig. 2. VANET Applications .

TABLE I

Technique	Localization		
	High	*Medium*	*Low*
Vision Enhancement	X	-	-
Vehicle Col. Warn. System	X	-	-
Automatic Parking	X	-	-
Coop. Adapt. Cruise Control	-	X	-
Blind Crossing	-	X	-
Coop. Intersection Safety	-	X	-
Platooning	-	X	-
Routing	-	-	X
Map Localization	-	-	X
Data Dissemination	-	-	X

B. Medium Accuracy VANET Applications

In this group application required the accuracy to compute

ANet applications localization accuracy

- automatic parking
- cooperative driving
- map location
- driver assistance
- Internet access
- Comparative cruise control
- Driverless Vehicles
- security distance warning
- dissemination of road information
- vehicle collision warning

These applications are required to get advantages from the localization techniques [5]. Most of the VANET applications are totally based on the availability of the real-time position information. These applications are categorized on the basis of their accuracy and ability to work properly. Some of the applications are work with inaccurate localization position in the range of 1- to 30m, critical safety application required reliable and accurate position information and localization sys- tems. To better understand we categorized VANET application according to their localization requirements. Table 1 shows the localization requirements if VANET applications[6].

A. High Accuracy VANET Applications

High accuracy localization techniques required reliable and accurate localization systems. Critical applications are categorized in this group such as collision warning and driver assistance applications. Collision warning applications are very helpful for driver assistance in critical situations such as decelerates or suddenly brakes when a vehicle is in front of the driver. If the driver is unable to stop in time, the rear end accident is bound to occur. Driver assistance application is used to provide the complete information related to their surrounding environment such as curves, construction area, and speed limit, to improve the driver awareness about the specific area. These application the position information for vehicular nodes. Vehicular nodes are used to communicate with the other vehicle and exchange information and also adopt the partial control on the roads.

- *Cooperative Adaptive Cruise Control.*
  These types of application are used to control the speed limit, such as a driver set the speed limit for his vehicle and system automatically control the speed of the vehicle, especially when the vehicle is moving upward or downward. Only speed of the vehicle is controlled by these applications, and all other functions are controlled by the driver. Radar sensor is used in these applications to calculate and measure the velocity using laser scanning[8].
- *Cooperative Intersection Safety Applications* Vehicular communicate with each together when they reached at the road junction. The road junctions that are without traffic lights, in this scenario vehicles communicate with other vehicles to cross this road junction safely. Localization accuracy is the most important part in these applications because with the accuracy they don't cross the road junction safely. Intersection is t main point of the accidents that are took please with in the city. Lot of applications are developed to overcome this issue and provide intersection safety to the driver in critical situation[9].
- *Platooning applications* are used to make vehicles nodes more efficient to maintain the minimum distance between the vehicles at the same speed. In this application vehicles are travelling in a row and follow a leader vehicle, with the help of te accurate localization vehicle follow the lead vehicle with complete attention[10]. 802.11p is used for communication between the vehicles that are using the platooning application to communicate with each other for coordinating movement and safety. The success of this application is totally based on the vesical position [11].

C. Low Accuracy VANET Applications

Some VANET applications have a low accuracy rate due to inaccurate localization information, if accurate localization information provides to these applications they will perform better. These applications are mostly used in vehicle-to-roadside and V2V communications such as information routing, road congestion, accident detection, etc. Vehicles receiver information related to accident locations in accident detection application and the drivers take decision accordingly[17].

Protocols with Localization Different types of proto- cols are used to send position information between the sender and receiver, also deal with the unique VANET characteristics such as a high-mobility and changeable-topology. Routing protocol that are based on the posi- tion information are used for data-packet routing and locate the destination position [18]. Navigation system and GPS are used in these protocols for communication, different approaches are used in these protocols, greedy- forwarding approach is one of the most efficient and popular approaches nowadays[19,20].

TABLE II MY CAPTION

Applicatio	Messaging Type	Commu	Message	Latency
Forward Collision Warning System [12]	Event-triggered , Broadcast	V2V, V2I	100m	100m
Real-time traffic speed estimation [13]	Event-triggered Periodic broadcast	Ad-Hoc , V2V, V2I	50m	50m
Collision Warning Model [14]	Event-triggered, Broadcast	V2V	200m	200m
Intelligent Access Program [15]	Event-triggered Permanent broadcast Periodic broadcast	V2I , V2V	100m	100m
Arterial incident detection [16]	Event-triggered, Periodic permanent broadcast	V2I	100m	100m

In [16] authors proposed an application that is totally based on the loop detectors and probe-vehicles to detect the incident in real time and control the traffic. In [13] authors proposed system collects the data from the probe-vehicles and estimate the travel time and speed of the vehicles accordingly. Various types of sensors are used to collect information related to traffic and fusion- based estimation. Proposed application is used efficiently in urban traffic management systems. Bluetooth and GPS devices are used in this application.Movement of vehicles using GPS is monitored in [15].This system also collect the information related to the vehicle such as speed of vehicle, location, identification and sensor installed in the vehicle.In [12] authors use radar technology for short range communication and detection of collision warning. The proposed system collects information related to speed and calculate the braking time of the vehicles

Radar detection is used to calculate the braking time between the lead vehicle and host vehicles and broadcast the event- driving message and information using GPS. In [14] authors collect information related to vehicle speed, acceleration and other information in limited to me to avoid the collisions. Table 2 shows the different requirements of ITS applications.

II. VEHICULAR LOCALIZATION TECHNIQUES

There are a lot of localization techniques which are used to compute the position of the mobile-nodes. Most of the localization techniques are easily applied on the VANET. Fig 3 shows the number of localization techniques that are used in VANET for position estimation, named as Dead Reckoning, Map Matching, Image/Video Processing, Global Positioning System, Cellular Localization, Relative Distributed and Localization Services.

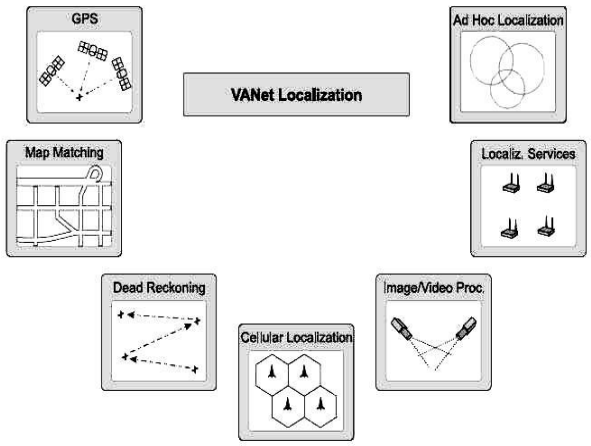

Fig. 3. Vehicular Localization Techniques.

A. Global Positioning System(GPS)

Global Positioning System is used to locate and navigate the mobile nodes and the vehicles in the network, GPS works with the help of 24 satellites that are operating in their orbit around the world [21]. The distance between the earth and the satellite is around 20,200 km and its complete 2 orbits every- day. The earth is divided in 6 regions and each satellite cover 4 regions accordingly. In vehicles GPS receivers are used to connect vehicle with the GPS to receive Information and ToA techniques is used for distance estimation [22].Vehicular receiver work with the localization information of VANET and it's also known the altitude, latitude and longitude. Nowadays there are many vehicle companies use GPS in their vehicle for tracking-distance, speed, mileage and localization, etc.[23]. For complete and correct information GPS receiver received three signal from the 2D positioning satellites and four signals from 3D positioning satellites. Obstacles such as electronic interface, rocks, dense foliage, buildings,

and in metropolitan areas, forests, underground spaces, tunnels and parking lots etc., which easily destroy the satellite signals and affect the accuracy of positioning. The reasonable distance error in GPS receivers for some applications are between 10m and 30m[24](Fig 4A).Example of localization techniques that are applied on VANET are shown in Fig 4.

B. Map Matching

Currently used Geographic Information System(GIS) is very advanced nowadays and its collect and store information, also collect the geographic data from the low power devices. City map information is stored in vehicle navigation systems using this technology (Fig 4B).Knowledge of map is not considered as a localization technique, maps are used to improve the

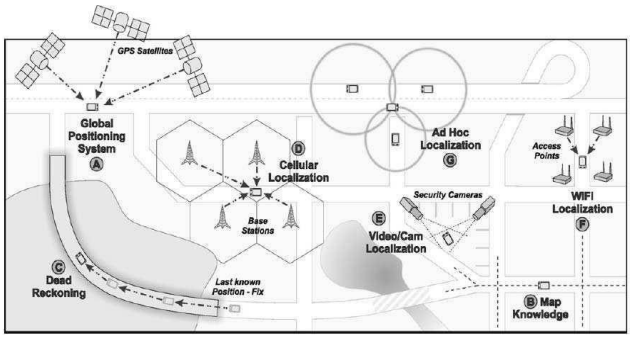

Fig. 4. Vehicular Localization Techniques Example.

GPS performance [25]. Map Matching technique having the main knowledge of the map. Map Matching technique collects the information from the different location over a regular time period and create the estimates trajectory. The created estimation trajectory is compared with the digital map data and find the suitable path using the GPS for accurate position information [26].

C. Dead Reckoning

Dead Reckoning is used to locate the current position of mobile nodes and collect information about the last location of nodes with the help of time, distance, speed and direction, etc. [27]. GPS receivers are used to collect then known position through digital maps [28].At the other end DR also collect the information about the current position of vehicular nodes with a bad GPS signals is VANET techniques that is used to collect the and combined the map information for a short time when GPS is not available. DR is working more efficiently in highway environments rather than metropolitan areas, because vehicles are moving straight and movement is easily predicted. DR is the best option in the absence of GPS.Dynamic topology and high-speed are the unique features of the VANET to accumulate the DR errors easily. That's the main reason DR is only used as a backup when GPS in not working. To overcome the errors of DR combines all the knowledge of maps and traffic pattern in Map Matching [26].

D. Cellular localization

Mobile cellular architecture is used in this VANET technique for object and position estimation in urban environments. These applications are used to track the domestic-animals, locate the mobile phones and vehicle localization[29]. Communication infrastructure is installed in each mobile cellular system to work properly. The base station in this area is responsible for communication between the mobile phones. Furthermore, only one base station is communication with the mobile phone at a time and other base stations, communication and listen the mobile phones communication at any time [30]. Received Signal Strength Indicator techniques is used to derive the distance between the base station using the strength of the received signals. It's also calculate the ToA or calculate the time when a signal is arrived at the multiple base stations. Fig 4D shows that a mobile station is connected with the three base stations, multilateration and trilateration techniques are used to compute the location of the mobile station [31]. The efficiency depends on different factors such as the number of base station that are used to detect the signal, environment of urban area, and algorithms are used for positioning. The range of error in most cases is between 90m to 250m [32]. Collection position information using this technique is more useful when its combined with the DR and Map matching.

E. Video/Image Localization

The image and video sources are also used in localization techniques different VANET application are used for secu rity in tunnels and parking lots with the help of installed cameras in these locations. Data fusion protocols are used in these approaches to track and analyze the vehicle location. Vehicle location parameters are calculated using image and video sources and sidelines are detected by the vision algorithms.Geometrical parameters of vehicle such as angle of direction, distance between vehicles and lanes, road lateral curve, camera inclination angle and lane width are used for estimation[33].

F. Localization services

GPS service is very important for VANET and in some places it's not available such as tunnels, parking lots and urban canyons. Communication infrastructure is needed to provide the services to vehicle nodes. UWB localization, Radar systems, cricket location support system and Wi-Fi localization are the popular localization systems. Radars are used RF based systems to track and localize the users inside the buildings. The radar systems collect the information and calculate the signal strength from the different base stations and combine all the collected information with the signal propagation models for node localization [34]. The UWB is totally based on ToA and its measure the high speed competence of every transceiver to complete two way ranges between them [35]. WiFi localization systems are used in airports, tunnels and in university campuses to track the vehicle location information. WiFi localization used the IEEE 802.11b/g standard for localization, tracking and identifications in VANET [36]. Development of localization system infrastructure is the main challenge in VANET for the areas where the access is limited such as tunnel.IN tunnels rescue operation is the most difficult task to overcome this issue indoor localization systems, cameras and image or laser scanners are used. WSN also used the VANET infrastructure to monitor noise, speed, visibility and temperature [37].

G. Distributed Ad Hoc Localization

Table Iii
Localization Techniques Comparison

	Localization Features			
	Infrastruct	*Accuracy*	*Availability*	*Synchroniz*
Map Matching	No	No	Yes	No
Cellular Loc.	Yes	No	No	No
Loc. Services	Yes	Yes	No	Yes
Dead Reckoning	No	No	Yes	No
Img/Video Loc.	Yes	Yes	No	Yes
Rel. Ad Hoc Loc.	No	Yes	Yes	Yes
Global Pos. System	Yes	No	No	No

Local relative position maps are VANET technique that is used to exchange information and estimate the distance between the vehicles. This localization technique is mostly used in ad-hoc and sensor networks. In [3], ODAM protocol was proposed to help the GPS localization systems to support unequipped vehicular nodes. Proposed algorithms are used to estimate the position of vehicles with the three nearby the algorithm take the distance and direction from the event and approximate the position of the vehicle. Furthermore, other sensor and relative ad hoc networks have been proposed to implement VANET. Different types of applications are used for estimation measurement. These types of applications are based on relative-positioning, but GPS is much batter then these applications. In other cases, relative-positions changed to global-positions [38].

III. COMPARISON

Different types of localization techniques are proposed to estimate localization in VANET. These techniques are not suitable for highly mobile and dynamic VNETS environment due to their own boundaries and limitations. The discussed solution required reliability in position estimation and accuracy and these solutions not fit in critical vehicular applications. Due to these flaws VANET need and efficient approach which is used in anytime and anywhere. Localization systems must be more efficient to deliver information on time and free from delay. Dangerous accidents are caused when information received with delay. We cannot rely on satellite system because some time satellite information can't have delivered properly. Single approach can't fulfill the requirements of VANET application requirements. Table 2 Shows some localization techniques comparison with respect to their technical aspects.

IV. CONCLUSION

In this paper different VANET localization application and techniques are studied. We demonstrate that how GPS receivers collect the most common localization information in VANET, it can be unavailable in some situations. After that we discussed that these inaccuracies of localization affecting the localization systems in critical issues. Different localization techniques are used to estimate the vehicle positions: image/video processing, Map matching, Cellular Localization, Dead Reckoning, Relative Distributed Ad Hoc localization and localization services. In this paper, we show that how these techniques used to compute the accurate vehicular position that are based on inaccurate position estimation.

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