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Comparative analysis of vehicle localization algorithms in vehicular Ah-Hoc networks using vehicle-to-vehicle communication model

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Abstract

The vehicular Ad-hoc network (VANET) is a dynamic technology in which vehicles communicate with each other and road side infrastructure, Sensing technology configure with road side infrastructure and on board units. The motion and communication in network is repaid and real time. VANET having great applications in traffic management, safety and comfort, infotainment and navigation. These applications critically depend on the location of vehicle in VANET. The localization in WSN is hot area of research and different researchers conducted research to discover efficient and accurate localization techniques to estimate the real position and location of vehicles in VANET. Various localization techniques have been proposed for vehicle coordinated detection which either GPS based or GPS free based localization. All these techniques have merits and demerits, but no single technique can satisfy all the requirement of critical VANET applications at same time such as availability anytime, anywhere, with high accuracy and reliable position of computation.

Keywords: VANET, localization, applications, accuracy

1. Introduction

A Vehicular Ad Hoc Network (VANET) derived the features of mobile Ad Hoc sensor networks (MANET). It VANET is the sub class of MANET, and it is a promising techniques for future modern intelligent transportation system (ITS). The Objectives are to provide effective safe driving, efficient management of traffic, automatic driving as well as infotainment, navigation to drive in pleasant environment both for messenger and driver [8], there is a critical impact of intelligent driving on accident and traffic monitoring. The VANET is different from MANET because it has a high dynamic topology, high power resources, highly densely deployed nodes, platooning deployment of nodes and not random deployment. In VANET, nodes are vehicles which communicate with each other and with road side infrastructure (RSI) and pedestrian. The sensing technologies are deployed on OBU of vehicle and road side infrastructure and communication models used are V2V (vehicle-to-vehicle), V2I (vehicle-to-infrastructure), I2V (infrastructure–to-vehicle), V2p (vehicle-to-pedestrian) and P2V (vehicle–to-pedestrian) and infrastructure-to- infrastructure (I-to-I) [1]. All VANET communication models use a dedicated short range communication (DSRC) spectrum and Wi-Fi IEEE 802.11p wireless access in vehicular environment(WAVE) and WiMAX IEEE 802.16 The direct communication between Vehicles referred to as inter-vehicle Communication (IVC) pure VANETs, is a relatively new approach. Compared to a cellular system, IVC has three key advantages: lower latency due to direct Communications, broader coverage, having no service fee, self-managing topology of network and no power resources constraints. The VANET information system /intelligent transportation information system (ITIS) based strategy are played important role in traffic management, infotainment navigation+ entertainment, road safety services, automatic driving so smart road and smart driving strategy with in ITS is possible [1]. All these applications definitely depend on the actual position/location of vehicle in the vehicular networks because the information transmitted by vehicle is significantly necessary for other vehicles movement in vehicular network. Localization of vehicle is critically import at core activity of VANET and this is hot area of research and different researchers has been taken serious interest to explore this hot area for intelligent driving. So far, different algorithms have been designed for localization of vehicle in VANET [2]. The localization of a vehicle compared to an event when it is informed for the existence of an accident or an imminent danger. It is a task of great importance that can avoid pile-up of vehicles and loss of human life. Currently, typical localization techniques integrate GPS receiver and motion sensors. However, when the vehicle passes through an environment that eclipses GPS information or creates a multipath effect, these techniques fail. Unfortunately, vehicles often travel in environments where GPS is not accessible. For these reasons, many techniques are proposed in literature to locate nodes in VANET [3], sensor networks [4], as well as VANET [5, 2, 6]. Some of these techniques show that how to determine the location of vehicles if only vehicles are equipped with GPS, whereas others present methods to determinate position using a local and global coordinate systems which need a lot of calculation [4], to discover the position of unknown vehicle in VANET. The efficient localization techniques are required in VANET communication model v2v or pure VANET communication model due to high critical applications.

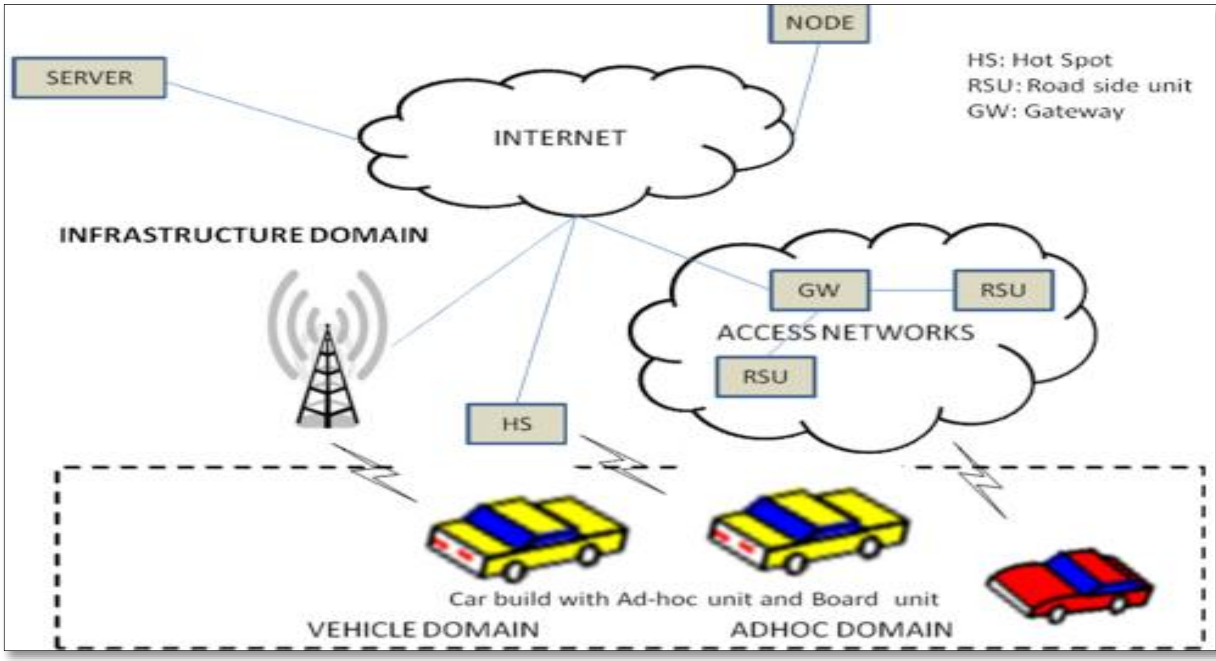

Fig 1: VANET Architecture

2. Localization Techniques in Vehicular Ad –Hoc Network

The critical applications in VANET require more reliable and high accurate localization system. A number of localization techniques for vehicle localization in VANET have been proposed to determine the position/ location of vehicle in different VANET communication models, namely GPS based localization, GPS free, Image/video localization, local services localization, ad-hoc localization, cellular localization, relative localization, map localization, dead reckoning localization, GIS localization, clustering localization, [7]. These techniques are presented through the following diagram

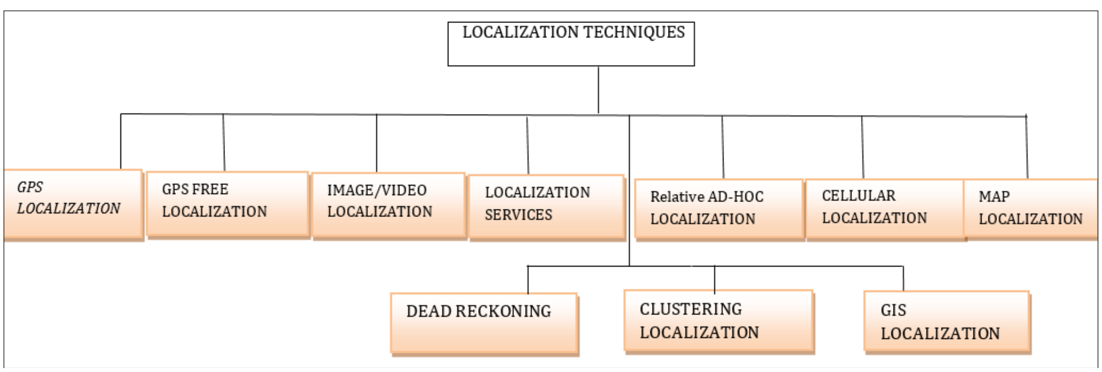

Fig 2: localization techniques in VANET.

Here we discuss shortly the above techies that how they can be used to find the location of vehicle in VANET/ITS

2.1 Global Positioning system based localization.

The GPS [12], is generally used for localization and discovered of objects, the GPS features are position within general global reference frame, GPS (longitudes, latitudes, altitudes) and Universal Transverse Mercator or UTM (zones and latitude bands), Relative position. The based on arbitrary coordinate systems and reference frames, distances between sensors (no relationship to global coordinates) and Accuracy versus precision of GPS. The global positioning system having 24 satellites revolving in 4 orbits around the earth, each orbit contains 6 satellites. The GPS high from earth is 20200 km to 36,000 km and complete two revolutions every day. The satellites are arranged in such a way that each point on earth can be referenced by four satellites [8, 9].The GPS globally used for deterring the location and position of objects on earth surface. In vehicular network the vehicle GPS receiver coordinates are unknown and GPS transmitter coordinates are known to find out the distance and position from GPS to GPS equipped vehicle can be determined by the ranged based techniques TOA, TDOA, A0A RSSI from three known satellites in 2D and position can be computed by Trilateration techniques [10]. And four known satellites for 3D localization, so by using these techniques vehicle can know latitude, longitude, and altitude. But, GPS not visible to all points to earth surface and also problem signals losing strength due reflection, scattering, multiple path delay and other environmental effect GPS based localization is not so effective for VANET critical applications.

2.1.1 Time of Arrival (T OA, time of flight)

The distance between sender and receiver of a signal can be determined using the measured signal propagation time and known signal velocity and sound waves:

One-way -ToA. One-way propagation of signal requires highly accurate synchronization of sender and receiver clocks.

$$dist_{ij} = (t_2 - t_1) * v$$

$$\text{Dist}_{ij} = \Delta t * v \quad (1)$$

Where dist is distance between sender node I and receiver node j and Δt is time and v is velocity of signal

TWO –way TOA**.** Round-trip time of signal is measured at sender device and third message if receiver wants to know the distance.

$$dist_{ij} = \frac{(t_4 - t_1) - (t_3 - t_2)}{2} * v \quad (2)$$

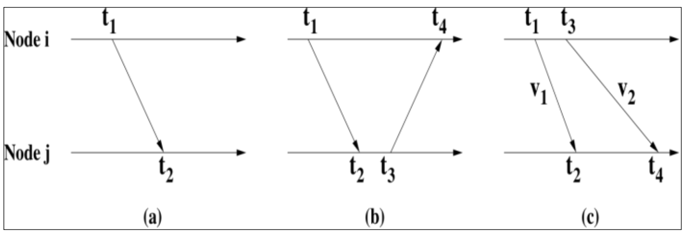

Fig 3

2.1.2 Time Difference of Arrival (TDOA).

The two signals with different velocities example: radio signal (sent at t_1 and received at t_2), followed by acoustic signal (sent at $t_3=t_1+t_{wait}$ and received at t_4).

$$dist = (v_1 - v_2) * (t_4 - t_2 - t_{wait}) \quad (3)$$

TD0A no clock synchronization required, distance measurements can be very accurate and need for additional hardware.

2.1.3 Angle of Arrival (AOA).

The A0A is ranged based localization techniques having direction of signal propagation, typically achieved using an array of antennas or microphones, angle between signal and some reference is orientation, spatial separation of antennas or microphones leads to differences in arrival times, amplitudes, and phases, accuracy can be high (within a few degrees), adds significant hardware cost.

2.1.4 Received Signal Strength (RSS).

This is ranged based techniques of localization having the features are signal decays with distance, many devices measure signal strength with received signal strength indicator (RSSI),vendor-specific interpretation and representation, typical RSSI values are in range of 0. RSSI_Max, common values for RSSI_Max: 100, 128, 256, in free space, RSS degrades with square of distance expressed by Friis free space model transmission equation

$$\frac{P_r}{P_t} = G_t G_r \frac{\lambda^2}{(4\pi)^2 R^2} \quad (4)$$

Where Pt is the transmitted power, p_r is receiving power of antenna, G_t is the transmitter antenna gain; Gr is the receiver antenna gain λ is the wavelength of the transmitter signal in meters. In practice, the actual attenuation depends on multipath propagation effects, reflections, noise, etc.

Realistic models replace R^2 with R^n (n=3..5).The RSSI measures the power of the signal at the receiver. Based on the known transmit power, the effective propagation loss can be computed. Since a measurement of signal strength provides a distance estimate between the MS and the BS (Base Stations), the MS must lie on a circle centered at the BS. According to [11].

Pr = Pt (c1/d)n. c2, where Pt is the power level on which the message is sent, Pr is the power level on which the message is received and *n*, *c*1, *c*2 are constants related to physical environment, the carrier's wavelength and antenna gains, respectively. Since Pr and Pt can be measured, the distance *d* can be estimated from this formula.

Non Free Space model:

$$p_r(d)=p_o(do)-10np \log10(d/d0)+xs: \quad (5)$$

Where p0 (d0) is a known reference power value at a reference distance d0 from the transmitter, po(do)-10np log10(d/d0 is the path loss exponent that measures the rate at which the RSS decreases with distance and Xs a zero mean Gaussian distributed random variable

2.1.5 Triangulation

It's ranged based techniques for position estimation of unknown vehicle from known vehicles position. its uses the geometric properties of triangles to estimate location Relies on angle (bearing) measurements Minimum of two bearing lines (and the locations of anchor nodes or the distance between them) are needed for two-dimensional space [12].

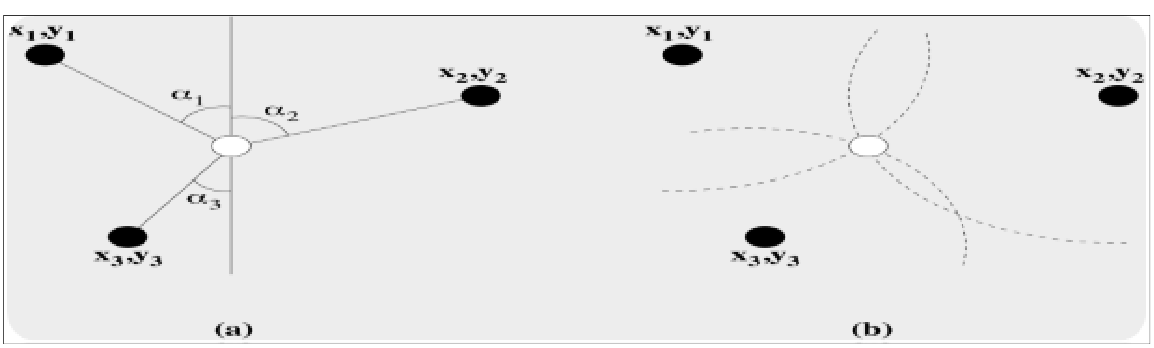

Fig 4

Here Unknown receiver location $\mathbf{x_r}=[x_r,y_r]^T$, Bearing measurements from N anchor points: $\beta=[\beta_1,\ldots,\beta_N]^T$ and Known anchor locations $\mathbf{x_i}=[x_i,y_i]^T$

The Actual (unknown) bearings $\theta(\mathbf{x})=[\theta_1(\mathbf{x}),\ldots,\theta_N(\mathbf{x})]^T$ so Relationship between actual and measured bearings is $\beta=\theta(\mathbf{x_r})+\delta\theta$ with $\delta\theta=[\delta\theta_1,\ldots,\delta\theta_N]^T$ being the Gaussian noise with zero-mean and NxN covariance matrix S=diag $(\sigma_1^2,\ldots,\sigma_N^2)$ and the Relationship between bearings of N anchors and their locations.

$$\tan\theta_i(\mathbf{x}) = \frac{y_i - y_r}{x_i - x_r} \qquad (4)$$

The Maximum likelihood (ML) estimator of receiver location is then

$$\hat{\mathbf{x}}_{\mathbf{r}} = \arg\min \frac{1}{2}[\theta(\hat{\mathbf{x}}_{\mathbf{r}}) - \beta]^T S^{-1}[\theta(\hat{\mathbf{x}}_{\mathbf{r}}) - \beta] = \arg\min \frac{1}{2}\sum_{i=1}^{N}\frac{(\theta_i(\hat{\mathbf{x}}_{\mathbf{r}}) - \beta_i)^2}{\sigma_i^2} \qquad (5)$$

This non-linear least squares minimization can be performed using Newton-Gauss iterations:

$$\hat{\mathbf{x}}_{\mathbf{r,i+1}} = \hat{\mathbf{x}}_{\mathbf{r,i}} + (\theta_x(\hat{\mathbf{x}}_{\mathbf{r,i}})^T S^{-1}\theta_x(\hat{\mathbf{x}}_{\mathbf{r,i}}))^{-1}\theta_x(\hat{\mathbf{x}}_{\mathbf{r,i}})^T S^{-1}[\beta - \theta_x(\hat{\mathbf{x}}_{\mathbf{r,i}})] \qquad (6)$$

2.1.5.1 Trilateration

Localization based on measured distances between a node and a number of anchor points with known locations. Basic concept the distance to an anchor, it is known that the node must be along the circumference of a circle centered at anchor and a radius equal to the node-anchor distance in two-dimensional space, at least three non-collinear anchors are needed and in three-dimensional space, at least four non-coplanar anchors are needed.

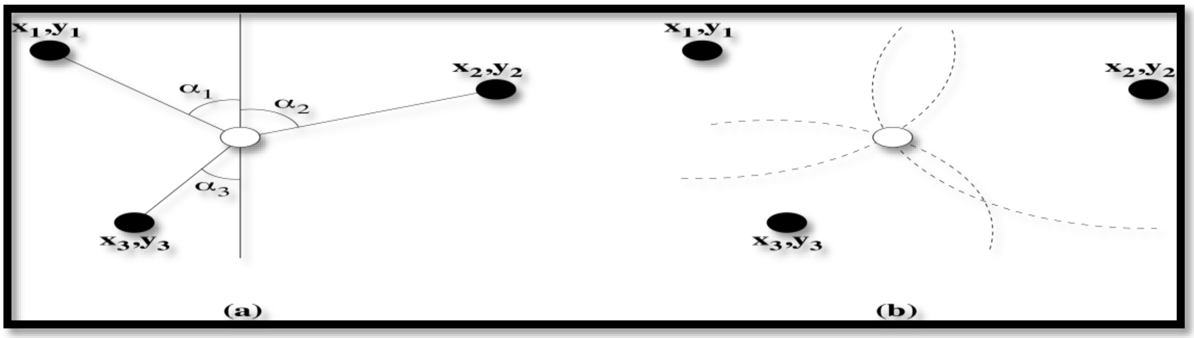

Fig 5

Here "n" anchor nodes: $\mathbf{x_i}=(x_i,y_i)$ (i=1..n), Unknown sensor location $\mathbf{x}=(x,y)$ and Distances between sensor and anchors known (r_i, i=1..n)

Then Relationships between anchor/sensor positions and distances (2 dimensions):

$$\begin{bmatrix} (x_1 - x)^2 + (y_1 - y)^2 \\ (x_2 - x)^2 + (y_2 - y)^2 \\ \vdots \\ (x_n - x)^2 + (y_n - y)^2 \end{bmatrix} = \begin{bmatrix} r_1^2 \\ r_2^2 \\ \vdots \\ r_n^2 \end{bmatrix} \qquad (7)$$

This can be represented as $A\mathbf{x}=b$ with:

$$A = \begin{bmatrix} 2(x_n - x_1) & 2(y_n - y_1) \\ 2(x_n - x_2) & 2(y_n - y_2) \\ \vdots & \vdots \\ 2(x_n - x_{n-1}) & 2(y_n - y_{n-1}) \end{bmatrix}$$

$$b = \begin{bmatrix} r_1^2 - r_n^2 - x_1^2 - y_1^2 + x_n^2 + y_n^2 \\ r_2^2 - r_n^2 - x_2^2 - y_2^2 + x_n^2 + y_n^2 \\ \vdots \\ r_{n-1}^2 - r_n^2 - x_{n-1}^2 - y_{n-1}^2 + x_n^2 + y_n^2 \end{bmatrix}$$

Based on this least squares system, we can obtain estimation of position (x,y) using

$$x=(A^TA)^{-1}A^Tb: \qquad (8)$$

Anchor positions and distance measurements are inaccurate; therefore, if they are based on Gaussian distributions, we can assign a weight to each equation *I*:

$$w_i = 1/\sqrt{\sigma^2_{\text{distance}_i} + \sigma^2_{\text{position}_i}} \quad \sigma^2_{\text{position}_i} = \sigma_{x_i}^2 + \sigma_{y_i}^2$$

The least squares system is then again $A\mathbf{x}=b$ with:

$$A = \begin{bmatrix} 2(x_n - x_1)\times w_1 & 2(y_n - y_1)\times w_1 \\ 2(x_n - x_2)\times w_2 & 2(y_n - y_2)\times w_2 \\ \vdots & \vdots \\ 2(x_n - x_{n-1})\times w_{n-1} & 2(y_n - y_{n-1})\times w_{n-1} \end{bmatrix}$$

$$b = \begin{bmatrix} (r_1^2 - r_n^2 - x_1^2 - y_1^2 + x_n^2 + y_n^2)\times w_1 \\ (r_2^2 - r_n^2 - x_2^2 - y_2^2 + x_n^2 + y_n^2)\times w_2 \\ \vdots \\ (r_{n-1}^2 - r_n^2 - x_{n-1}^2 - y_{n-1}^2 + x_n^2 + y_n^2)\times w_{n-1} \end{bmatrix}$$

The covariance matrix of x is then $Cov_x=(A^TA)^{-1}$

2.2 GPS Free Localization
The GPS based localization is cost effective and convenient but not efficient solution for accurate localization of vehicle in VANET so relative localization techniques used for localization. The location information obtained from network topology by routing mechanisms.

GPS-unequipped localization. The GPS free localization technique used for VANET and no GPS receiver installed on vehicle so different algorithms used which no need GPS these algorithm are

2.2.1 ODAM [5], this algorithm relies on the periodic computation of its driving direction, previous and current positions, some modifications have to be envisaged to make GPS-U vehicles know these positions when the communication with the GPS satellite is not possible. DAM can be executed normally if these positions are accurately known; however, this is not always possible. In some situations, GPS-U vehicles can't obtain their exact previous and current positions. However, they can obtain some information about the driving direction and the distance from the accident. This can help the driver to take decisions. For example, if the accident happens in the opposite driving direction according to the accident in a divided highway there will be no need to brake.

2.3 Image /Video Localization.
The source image/video information and date can be used to determine the location of vehicle in VANET. Image/video processing techniques are used to feed data fusion algorithm [8] the image and video are achieved from camera which install on road side or tunnels or security and different techniques are used to compute the location of vehicle. This techniques localized the vehicle in small coverage area but accuracy is high and not globally implemented [13].

2.4 Map matching localization
In the Map Matching [14] technique, several positions obtained over regular periods of time can be used to create an estimated trajectory. The estimated trajectory is then compared to the known digital map data to find the most suitable path geometry on the map that matches the trajectory. Using this technique, position information (e.g., from GPS) can be accurately depicted on the map.

2.5 Localization services
A Localization Service can be implemented by using any known infrastructure localization system; such as the Cricket Location-Support System [15], RADAR, Ultra-Wideband Localization [16], or Wi-Fi Localization [17, 18], Thangavelu and al. propose a system called "VETRAC", a vehicle tracking and location identification system designed for VANET that uses Wi-Fi access points as a communication infrastructure. The proposed system can be used in tunnels, university campuses, airports, etc. VANET, s can also use Wireless Sensor Networks (WSNs) as the base for a VANET localization infrastructure.

The reason for doing this is that WSNs can also be used to monitor other road variables like movement, temperature, smoke, visibility, and noise. Thus, these networks are ideal for monitoring critical environments, as well as for emergency operations, as shown by a number of works [19]. Also, the use of sensor networks as a roadside communication infrastructure is an envisioned scenario in many Intelligent Transportation Systems. A number of WSN features can also be used to improve the performance and accuracy of an infrastructure VANET localization system. For instance, movement sensors can be used to send localization packets only when vehicles are presented.

2.6 Dead Reckoning
By using Dead Reckoning [20], technique is used to compute the current position of a vehicle based on its last known location and using such movement information as direction, speed, acceleration, distance, time, etc. The last known position, also known as a fix, can be obtained, for instance, by using GPS receivers (which are most common) or by locating a known reference (road crossing, parking lots, home, etc) on a digital map. Displacement information can be obtained by sensors including odometers, while direction can be estimated easily using such other sensors as digital compasses and gyroscopes. Practically Dead Reckoning can be used only for short periods of GPS unavailability, or be combined with Map Knowledge. The reason to avoid the use of this technique over long periods of time is that it can accumulate errors easily. For instance, positioning errors from 10 to 20 m can be reached in only 30s after the last position fix when traveling at about 100 km/h.Since Dead Reckoning accumulates errors rapidly over time and distance, it is considered only as a backup system for periods of GPS outage, in which a vehicle enters in to a tunnel and loses its GPS connection. In this example, the last GPS computed position is used as a position fix. Another viable application of Dead Reckoning, as noted above, is to combine it with Map Knowledge. In these cases, the positions restrictions can be applied to decrease Dead Reckoning errors, and the traffic patterns can be used to match the estimated path within the known map information (map matching) [21].

2.7 Cellular localization
Cellular localization [22] use e mobile cellular infrastructure present in the most urban environments to discover the position of a vehicle. This technology includes locating mobile phones, tracking domestic animals, and vehicle localization. In order to work properly, mobile cellular systems require the installation of a communication infrastructure composed of a number of cellular base stations distributed through the covered area. Cellular localization is usually less precise than GPS. The accuracy depends on a number of factors such as the current urban environment, the number of base stations detecting the signal, and the positioning algorithm used, etc. Also, signals from the Cellular infrastructure have more availability in urban environments than signals from satellite (used by GPS receivers) which can be useful for indoor environments such as parking lots and even tunnels.

2.8 Relative Ad-Hoc localization
By the exchange of the estimated distances between the vehicle and its neighbors, a local relative position maps can be constructed. With this dynamic position map, a vehicle can locate itself relatively to nearby vehicles as well as locate the vehicles in its vicinity [10]. This type of relative localization has been used mostly in Ad Hoc and Sensor Networks [3], but recently a number of solutions [22, 5, 6] have been proposed for VANETs.

2.9 Data Fusion

Data Fusion techniques such as Kalman Filters, Particle filters, and Belief Theory have also been used to improve location estimations in many sensor-based systems [23] The key idea is to combine information from a cooperative vehicle ad hoc network using a Data Fusion module to allow vehicular safety applications to determine not only a vehicle's location, but also the lane in which it is traveling. The general idea behind a location system based on Data Fusion is to combine several information sources to provide accurate location estimation. In order to find an appropriate data fusion [24] algorithm, several basic approaches are taken into account as a)Usage of 2nd order statistics, b) Dempster-Shafer method, c) Rule based systems/ Fuzzy logic

2.10 Clustering localization

Clustering technique [25], which consists to determine the positions of nodes, in a vehicular Ad hoc NETET when no GPS information is available it based on the clustering technique and uses the Trilateration method for the establishment of the relative positions of the nearby nodes. This solution can be executed in three phases:

Phase 1: Selection of the first cluster head to be the center of the system and calculate the relative positions of all its neighbors in the group. Phase 2: According to the first cluster head selected in the previous step, we choose the other cluster heads (CH) and their coordinates in the system. Phase 3: This step will execute only if the chain of cluster heads is broken.

2.11 GIS localization

In GIS localization [26], a map is obtained from GIS for localization in VANET. The image of vehicle is extracted from map by image filtration techniques [27]. The image of particular road network is obtained from Google earth or from map info and then using different techniques for extraction the location of vehicle. This is very reliable and efficient techniques of localization in VANET.

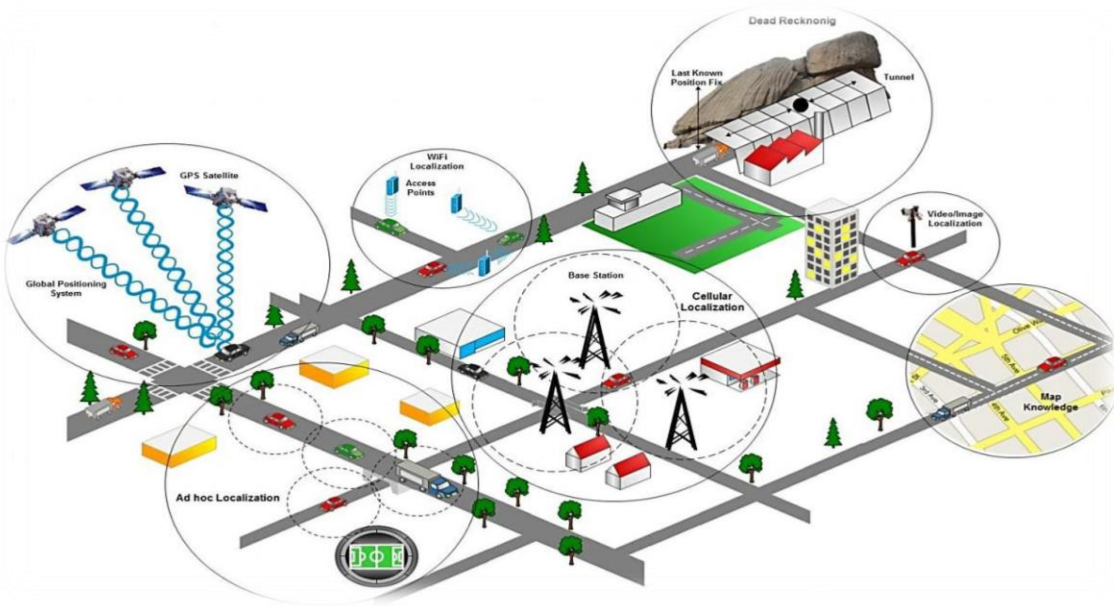

Fig 6: VANET localization techniques

3. Cross Tabulation Analysis of Parameters used in Localization Techniques

The localization techniques designed for vehicular ad-hoc networks used different parameters used by different researchers to increase the accuracy of localization of vehicle. In these parameters some having direct relation with each other and some parameters having inversely relation. These parameters' which used by researchers in their localization algorithms are cost, Delay, Scalability, Reliability, distance, Speed, Time, Energy, Network Life Time, Message Overhead, Robustness RSSI, Packet Drop, Network Capacity, Bandwidth, Efficiency, Security, The relation is described in table direct relation between two parameters is represented with tick mark "✓". And no relation is represented cross mark, "x". But, here we just cheek co-relationship between the variables

Table 1: Parameters Interdependence Relationship used in Vehicle Localization Techniques

	Accuracy	Network capacity	Distance	cost	Efficiency	Security	Reliability	Delay	Scalability	Energy	RSSI	packet Drop
Accuracy	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓
Network Capacity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Distance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost	X	✓	✓	X	X	X	X	X	X	X	X	X
Efficiency	✓	X	✓	X	✓	X	✓	✓	✓	✓	✓	✓
Security	x	✓	X	X	X	X	✓	✓	✓	✓	X	X
Reliability	✓	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓
Delay	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
Scalability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Energy	X	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓
RSSI	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓
Packet Drop	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

From the above table we concluded that all mention parameters of localization in VANET are critically important, which have directly impact on localization if we ignore these critical parameters in localization strategy then definitely localization algorithm not achieved the requirement of reliability vehicle localization in VANET. However some parameters which consider to be used in localization techniques are not so critically impacts on localization techniques used in VANET and among these parameters so may be consider to ignored

Statistical Analysis on the above Table:

Let we consider that accuracy is dependent variable and delay, cost, security, scalability, energy, efficiency, packet drop, synchronization, RSSI, distance, network size, time are independent variables and it can be written statistically as

$$Y=\alpha+\beta_1 x_{1i}+\beta_2 x_{2i}+, \text{----} +\beta_{ki} X_{ni}+€_i \quad (9)$$

Here y is the dependent variable, α is the intercept, β_s are the slope coefficient and x_s are independent variable and $€_I$ the effect of all missing variables which are not consider x

4. Comparative Analysis of localization Techniques in Vehicular Ah-Hoc network

We compare these localization algorithms on bases of these parameters which are possible criteria for judgment that which one is better algorithm among the various algorithms for accurate localization of vehicle in v2v communication model. These parameters are Throughput, cost, Latency, Delay, Scalability, Reliability, QOS, Distance, Speed, Time, Reach ability, Control Overhead, Node Mobility, Energy, Network Life Time, Message Overhead, Robustness, End-to-End Delay, Routing Overhead, RSSI, feeding of signals, Packet Drop, Network Capacity, Bandwidth, Node Velocity, Handover, Efficiency, Hop Count, Power Consumption, False Positive, Detection Rate, Security, Security Cost, Resiliency, Network Workload, Congestion Control, Load Balance and direction of signals arrival. Accurate localization algorithm has been critically played important roles in various applications of intelligent transportation system and in intelligent driving. So that why different researchers designed such algorithms that concisely identified the location and position of unknown vehicle VANET. In this work we compared different vehicle localization techniques

Table 2: Comparison of vehicle localization techniques in VANET

Techniques	Accuracy	Scalability	A viability	Delay	Distance	Time	Energy efficient	Cost	synchronization	Reliability	Infra-structure	Packet Drop	Routing overhead	Message overhead	security
GPS localization	Medium	High	high	High	High	large	less	High	large	High	High	Medium	Less	Low	low
GPS Free localization	Medium	low	low	low	low	low	Medium	low	low	Medium	low	low	High	Low	High
Map matching	High	low	low	low	Medium	medium	High	low	low	high	low	low	Low	Low	High
Dead reckoning localization	High	low	High	Medium	low	low	low	low	High	High	low	low	low	Medium	medium
Cellular localization	High	Medium	Medium	low	low	low	low	Medium	High	High	low	low	Medium	medium	Medium
Image /video base localization	Medium	low	low	low	low	low	medium	low	Medium	High	low	low	medium	low	high
GIS based localization	Medium	High	low	High	low	high	high	High	High	High	High	High	Medium	low	High
Clustering based localization	Medium	low	low	low	low	low	low	low	High	High	low	low	medium	low	Medium
Local services based localization	High	low	low	low	low	low	low	low	High	High	low	low	low	low	High
Data Diffusion based localization	low	low	low	low	low	low	low	low	High	Medium	low	low	low	low	High
Ad hoc base localization	High	low	Medium	low	low	low	low	low	High	High	low	low	low	low	High

5. Conclusion

In this research paper we critically diagnosed various vehicle localization techniques in VANET on the basis of some parameters. However every localization techniques have some merits and demerits. in this paper we reached on conclusion that hybrid localization system strategy are necessary for efficient and accurate localization of vehicle in VANET in which all localization techniques are integrated to design reliable protocol for traffic related critical applications.

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