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DYNAMIC PATH PRIVACY OVER ROAD NETWORKS

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ABSTRACT

In this paper, we proposed a novel dynamic path privacy protection scheme for continuous query service in road networks. Our scheme also conceals DPP (Dynamic Path Privacy) users' identities from adversaries; this is provided in initiator untraceability property of the scheme. The security analysis is shown that the model can effectively protect the user identity anonymous, location information and service content in LBSs. All simulation results confirm that our DPP (Dynamic Path Privacy) the scheme is not only better accuracy than the related schemes, but also provides better locatable ratio where the highest it can be around 95% of unknown nodes those can estimate their position. Furthermore, the scheme has good computation cost as well as communication and storage costs .Simulation results show that DPP (Dynamic Path Privacy) has better performances compared to some related region based algorithms such as IAPIT scheme, half symmetric lens based localization algorithm (HSL) and sequential approximate maximum a posteriori (AMAP) estimator scheme.

Key Words: LBSS, Localization, Range-Free, Continuous Query, Road Network

INSPEC Classification : A9555L, A9630, B5270

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1. INTRODUCTION

The location based services refer to cooperate through mobile terminals and network to determine the actual location of the mobile users, provides mobile applications with location information, so can achieve various services related to the user's location. The existing LBS service system consists of three parts: basic user terminal, Anonymous Server and LBS Server (Imran Memon, et.al, 2015). However, the existing research is based on the hypothesis that the anonymous device is safe and reliable, and the reliability of the anonymous apparatus at present has not been proved (K. Moghraoui,et.al,2010).

Existing LBS system is mostly based on a central server, which is based on the anonymous server and existing research is under the assumption that the anonymous server itself is reliable; however, there is no authority certificate to prove the reliability of anonymous server (R. Lu, X. Lin,et.al,2012 Once the anonymous device is attacked successfully, the user's privacy will get a serious threat. However we can divide area based localization algorithms into three types of primitive geometric shapes. The proposed scheme, in (WenHua Cheng,et.al,2012)] half symmetric lens based localization algorithm (HSL) (WenHua Cheng,et.al,2012) and sequential approximate maximum a posteriori (AMAP) estimator scheme (Zachariah,D, et.al,2014) . Hence, it is strongly required to propose and develop a new secure and efficient path privacy protection method for Continuous Query Services in Road Networks. To mitigate the above problem, we propose a new region based localization algorithm, a typical range-free scheme called DPP (Dynamic Path Privacy) algorithm. For example, range based schemes perform more accurate than the full range- based schemes. Our main contribution as follows:

1. We confirm that our DPP (DYNAMIC PATH PRIVACY) the scheme is not only better accuracy than the related schemes but also provide better locatable ratio where the highest it can be around 95% of unknown nodes those can estimate their position.

2. Our method permits a non-localizable object to utilize the unenthusiastic information to moderate its location indecision. Furthermore, this scheme gets a good computation cost as well as communication and storage costs.

3. Our proposed scheme does not require any information from neighboring LBSs services s, it uses only users' information, and so keeps computation and transmission overheads as low as possible.

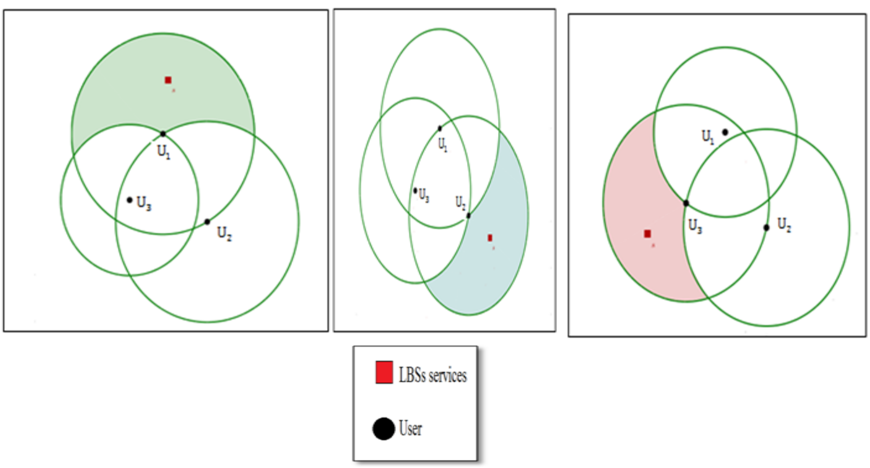
4. Finally, we proposed scheme is to have better performance than improve APIT scheme (WenHua Cheng, et.al, 2012), half symmetric lens based localization algorithm (HSL) (Zachariah,D, et.al,2014) and sequential approximate maximum a posteriori (AMAP) estimator scheme by using only the same parameters. Our DPP (DYNAMIC PATH PRIVACY) method has been designed on a precise geometric shape to draw the LBSs services' region.

2. SYSTEM MODEL

So in this scenario, we have designed the approach which allowed us to describe a novel way to devise the LBSs services region. Let, , and , be three adjacent users for the LBSs service with mysterious position, as represented in figure. We suppose that user is the closest user for ,as shown in figure 1(a), In this scenario we have to draw two circles, the first one is the circle centered at with radius equal to distancebetween and , and the second circle is centered at with radius equal to distance between and . If the LBSs services is at distance to and longer than the radius of the two circles and correspondingly, then the LBSs services must be external the geometric figure described by the combination of the two circles and .Thus, the actual region for is the region of the network except the region of the union of two circles and.

We delimit the actual residence region for LBSs services by sketching a third circlecentered at the closest user with radius equal to the longer distance between and .figure 1(a) illustrates the final region for LBSs services by the region with green color.

Figure 1(b) and (c) illustrate cases when LBSs services is closer to users and , respectively .Therefore, we note that for one combination of three neighboring users ,we can get three different geometric shapes to be candidate regions for LBSs services s (green region in figure 1(a), blue region in figure 1(b) and red region in figure1(c)), according to the RSSI values between a LBSs services and each neighboring user . In contrast, APIT scheme can construct only one residence region for LBSs services s which is inside triangle region. We conclude that with our solution we can cover a larger region of network compared with APIT scheme and this is because the total surface region of our specific geometric shapes (union of three different geometric shapes illustrate in figure 1 is greater than the surface region of triangle and this lead to high number of nodes that can locate themselves.



(a)istheclosestusertoLBSsservices,(b) U_2istheclosestusertoLBSsservices
(c) U_3istheclosestusertoLBSsservices

Proposition I :(Find the closest user)

The LBSs services are closer to at least one user U_1, U_2 *or* U_3 . If and only if:

$$\left.\begin{array}{l} d_{s,U_1} < d_{s,U_2} \& d_{s,U_1} < d_{s,U_3} \\ Or \\ d_{s,U_2} < d_{s,U_1} \& d_{s,U_2} < d_{s,U_3} \\ Or \\ d_{s,U_3} < d_{s,U_1} \& \ d_{s,U_3} < d_{s,U_2} (1) \end{array}\right\} \quad (1)$$

2.1 Communication Model

APIT scheme is presented in (WenHua Cheng,et.al,2012) uses the RSSI values comparisons between neighboring LBSs services s and neighboring users to allow an unknown node to verify either a neighboring LBSs services are closer to /far than a given user. The validity of this assumption is tested on MICA mote, and the experimental results show that RSSI values decline monotonically with escalating distance. Furthermore confirm that is possible to indicate near /far LBSs services based on RSSI measurements. (Noureddine Lasla, et.al, 2015).

As our proposed scheme DPP (Dynamic Path Privacy) is based on the same parameters of APIT scheme, DPP (Dynamic Path Privacy) uses also the RSSI measurements. However, instead of using the neighboring LBSs services s' information to check the closer/farther neighboring LBSs services, DPP (Dynamic Path Privacy) is based only on the node own information where it uses the RSSI values comparisons between the unknown node itself and its neighboring users to determine the LBSs services residence region. With avoidance of neighboring LBSs services s' information, our proposed scheme does not need any communication among LBSs services s and this will reduce the communication and processing costs of our proposed scheme compared to the previous schemes.

2.2 Algorithm Description

In our future algorithm, LBSs services have to determine their location on the basis of the beacon information send out by users. Initially, each LBSs services determine its region with different audible user combinations (varying combinations of three neighboring users). Once done, LBSs services estimate its position as the Center Of Gravity (COG) of the intersection of all residential regions obtained. Moreover our designed scheme based upon five steps:

Step1: User's detection

Each user begins spreading a beacon message which includes its location information. LBSs services s and users can obtain this beacon message when they are inside the radioÊcommunication range of each other. Each user constructs its neighboring user list represented by NNu. Each raw in the NNu includes: the user's ID, the user location (i.e. Xu_i, Yu_i) and the RSSI corresponding to the received beacon message from the user which we denote it by RSSI. Then each user broadcasts the collected information to neighboring LBSs services.

Step2: Collection of localization information

The LBSs services collect critical information from all the users that it can hear and constructs its user heard list denoted by NUlbss. every raw in the NUlbssinclude: the user's ID, the user location, the RSSI equivalent to beacon message received from the adjacent user which is represented as and the RSSI values of user equivalent to beacon messages received from the adjacent users is represented as which is acquired from NAs lists. Furthermore, LBSs services construct another list that contains all possible combinations of three users heard. We denote it by ACs.

Step 3: Region formation

After collecting neighboring users' information, the LBSs services node can determine its residence region. For three given users heard:,and ,we assume that LBSs services is closer to user ,if and only if :. Moreover, if we have: Then, LBSs services should reside outside the geometric shape defined by the union of the two circles and, where is centered at with radius equals to distance between and, and circle is centered at with radius equals to distance betweenand. The geometric shape where the LBSs services reside is known as the complement of Combine Mode Union, which is the region of the network except the region of the union of two circles and. We denote it by .This initial residence region can be delimited and as the LBSs services is closer to user , it should be at least be inside the circle centered at with radius equals to the largest distance or between users and or between users and ,respectively. Therefore, the final residence region will be the intersection between the region and the circle

Dynamic Path Privacy of a LBSs services

The Let **NU**$_{lbss}$ be the set of neighbor users for a LBSs services.
Let ACs be the set of all possible three users' combinations from **NU**$_{lbss}$list.
A be the region of the network.
$R_{i,j,k}$ be the region of the LBSs services
for each **sub-set (U$_j$, U$_j$, U$_k$)∈ ACs** do
Let **U$_i$** be the nearest user **then**
If$RSSI_{s,U_j} < RSSI_{U_i,U_j}$ and $RSSI_{s,U_k} < RSSI_{U_i,U_k}$
$R_{i,j,k}$=Z \ $\overline{CMU}(U_j, U_k)$
$R_{i,j,k}$=$R_{i,j,k}$∩ C_{U_i}
end if
end for
End

Step 4: Location region refinement (overlapping region)

LBSs services s can determine their final residence region based only on arithmetic operations. Since it would be computationally expensive for each LBSs services to perform the arithmetic operations, we propose employing a grid scans algorithm that defines the overlapping region.

The grid scans algorithm has been previously used by APIT which scans each grid in the entire network region and so that it would cost too much computation time. Thus, we propose a modified grid scan algorithm which merely scans each grid in a box region within the network region.

The unknown node can receive beacon message when it is within the radio of communication range of neighboring users. So, based on the coordinates of neighboring users and the radius of communication range, we define a box region for each LBSs service, which we expect it can reside in. This box region is given by all coordinates satisfying

Where:
is the minimum x-coordinate value amongst all x-coordinate values of users.
is the minimum y-coordinate value amongst all y-coordinate values of users.
is the maximum x-coordinate value amongst all x-coordinate values of users.
is the maximum y-coordinate value amongst all y-coordinate values of users.
R is the radius of communication range.

Our grid scan algorithm involves three steps: 1) the LBSs services place a grid of equally spaced points within its box region, as depicted in figure 2(a). 2) For each grid point, the LBSs services holds a score in a grid score table with initial values equal to zero and for each grid point, the LBSs services performs a grid-region test to check if the grid point is included in our specific geometric shape. If the test is positive, LBSs services increments the corresponding grid score table value by one, otherwise the value remains unchanged, as showed in figure 2(b). This process is repeated for all the grid points.

Grid-region test:
A grid point is included in our specific geometric shape if it satisfies the following conditions. We assume that is the closest user to LBSs services:

$$\|P_q - U_i\| \leq R \quad \text{and} \quad \|P_q - U_j\| \leq R \quad \text{and} \quad \|P_q - U_k\| \leq R \qquad (2)$$

$$\|P_q - U_j\| \geq \|U_i - U_j\| \text{ and } \|P_q - U_k\| \geq \|U_i - U_k\| (3)$$

$$\|P_q - U_i\| \leq \|U_i - U_j\| \text{ or } \|P_q - U_i\| \leq \|U_i - U_k\| (4)$$

The step (2) is repeated for all possible three neighboring users' combinations. The overlapping area is explained by the grid points that contain the maximum score in the grid score table.

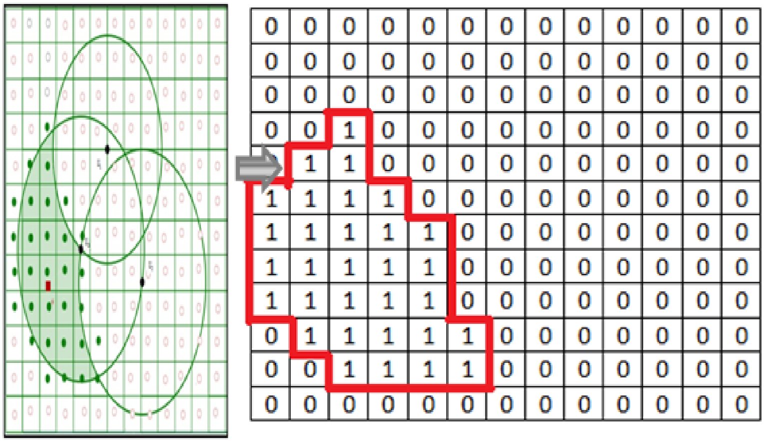


Figure 2: (a) step 3 and 4: region construction and placement of a grid of equally-spaced points in the search region, (b) step 4: the corresponding grid score table.

Step 5: Location estimation

The LBSs services determine its location as the centroid of all the grid points that define the overlapping region (as shown in figure 2(b), this region is delimited by red line):

$$(x_{est}, y_{est}) = \left(\frac{1}{T}\sum_{q=1}^{T} x_{p_q}, \frac{1}{T}\sum_{q=1}^{T} y_{p_q}\right) \qquad (5)$$

3. SIMULATION RESULTS

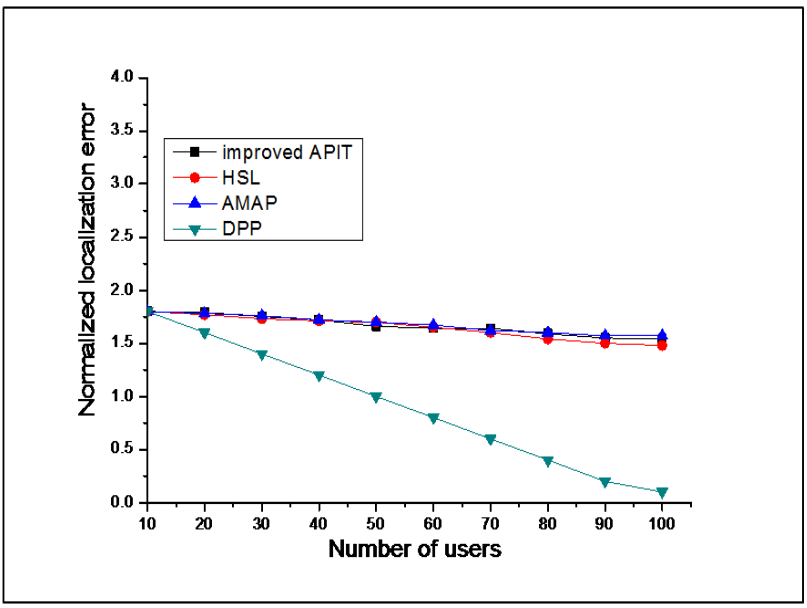
In this section, we compare the performance of our localization scheme DPP (DYNAMIC PATH PRIVACY) with other well-known range-free localization approaches improved APIT which we noted by IAPIT, half symmetric lens based localization algorithm (HSL) and sequential approximate maximum a posteriori (AMAP) estimator scheme .We conduct simulations using NS-3 Simulator.

3.1 Localization error vs. Number of users

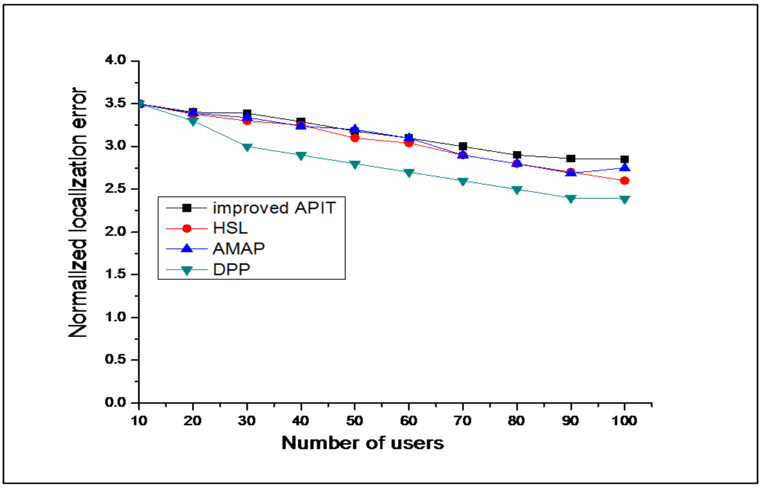
In this experiment, we study two effects which are the equal number of users and node density on the localization errors. Therefore, we fix the number of nodes to 200, the communication range to 43m, and the user's number is tuned between 10 to100 with step 10. To change the node density we use two different sizes of the deployment region: (250m×250m) and (400m×400m).Figure 3(a) and 4(b) show the association among the localization error and number of users when the size of network has been designed to the size (250m×250m) and (400m×400m), correspondingly. So from the above discussion we can see that the localization errors decrease when increasing the of users for the four schemes represented. This can be explained by the fact that these schemes are based on the LBSs services' region. Thus, as well as the number of users increases, the probability to have successful presence test increases, and hence smaller residence regions and lower estimation error are obtained.

The curve with the label IAPIT and the curve with the label HSL, AMAP is almost the same curve. As it was discussed in the related work section, the improvement made by IAPIT is about the manner of determining the LBSs services location of HSL and AMAP schemes, which does not have a great impact on the estimation error, because IAPIT, HSL and AMAP schemes still suffer from the incorrect decision about the LBSs services region which depends on the neighbors nodes. In contrast, in our proposed scheme this is the curve with label DPP (Dynamic Path Privacy). The estimation error is always below the both curve with label APIT and IAPIT. The accuracy of our scheme can be explained by using the perfect test to check the presence of LBSs services on a location region.

It can also be observed that the localization errors of the four algorithms in figure 3(b) are larger than that in figure 3(a).This is due to the decreasing on the average number of neighboring LBSs services s and neighboring users per unknown node radio region from figure 3(a) to figure 3(b). Thus, it is clear that the localization accuracy will be influenced because four represented schemes rely on neighboring user's number to obtain an accurate region. Furthermore, IAPIT, HSL and AMAP unlike our scheme, are sensitive to the number and placement of neighboring LBSs services s which directly affect the correctness of the LBSs services presence tests.



(a) Network size (250m×250m)



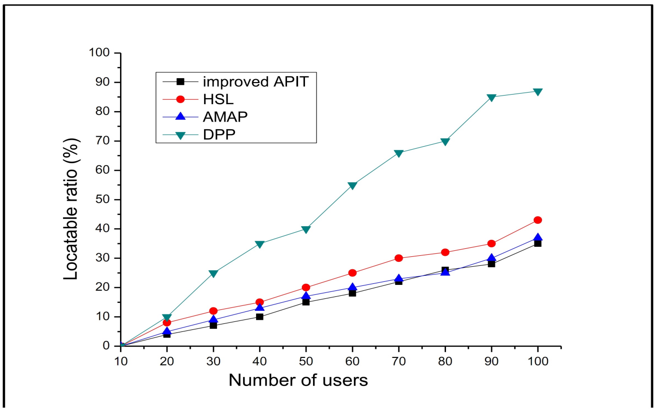
(b) Network size (400m×400m)
Figure 3: Localization error Vs Number of users

3.2 Locatable ratio Vs User percentage

Now, we study the impacts of the number of users and node density on the Locatable ratio. We fix the number of nodes number to 200, the range communication to 43m, and the user's number is tuned between 10 to 100 with step 10.We can observe, in figures 4, the two curves label IAPIT, HSL and AMAP are congruent. This happens because the proposed scheme IAPIT, HSL and AMAP does not provide any assumption to improve the number of locatable nodes in APIT. It focuses only on how to reduce the localization error. As explained in the related work section, the presence test of schemes IAPIT, HSL and AMAP can fail. Therefore, it can cause In-To-Out error which lead to low locatable ratio. However, our proposed scheme, which is the curve with label DPP (Dynamic Path Privacy), is always above the both curves. By using the perfect test to check the presence of LBSs services within a specific geometric shape, our scheme is characterized by its capability to contain several nodes that lead to high locatable ratio compared to IAPIT, HSL and AMAP schemes.

By comparing figure 4(a) (high node density) and figure 4 (b) (low node density), we show that locatable ratio of the four algorithms in figure 4 (b) is lower than that in figure 4 (a). This is because number of neighboring users and neighboring LBSs services s per unknown node decrease. Thus, the unknown nodes are relatively too far from the user nodes to hear the beacon signals, consequently, several anonymous nodes fail to estimate their location.

Another reason for the poor performance of IAPIT, HSL and AMAP at low node density is that the correctness of the presence test, depends on the availability of a sufficient number of user and placement of neighboring LBSs services s, and hence the ratio will be influenced. However, in our proposed scheme only the availability of neighboring users has an impact on our scheme. This is because there are no interactions between neighboring unknown nodes.



(a) Network size (250m×250m)

(a)Network size (250m×250m)

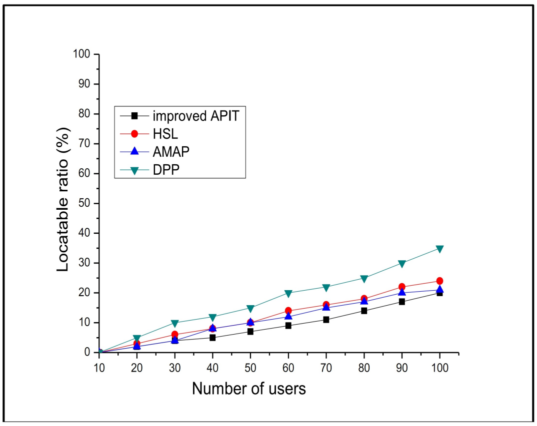


Figure 4: locatable ratio Vs Number of users
(b) Network size (400m×400m)
(c)

CONCLUSION

In order to improve the location accuracy, we proposed DPP (Dynamic Path Privacy) based Localization algorithm) scheme, a new distributed region based localization algorithm. DPP (Dynamic Path Privacy) scheme is designed to conquer APIT scheme a typical region based algorithm. By using the same parameters of APIT scheme as the same combinations number of three neighboring users and RSSI measurements for near/far relationship, DPP (Dynamic Path Privacy) scheme outperforms IAPI, HSL and AMAP T scheme because it adopts a perfect test to identify whether the unknown node is inside the specific geometric shape formed by three neighboring users. Hence the above results and simulation scenario has shown that our given scheme dramatically outperforms related region based schemes and improved IAPIT, HSL and AMAP.

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