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Novel roadside unit placement mechanism for 5G vehicular Adhoc networks in the urban environment

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Abstract

VANET plays a key role in an Intelligence transportation system. To avoid accidents and inform the traffic information, VANETs infrastructure plays an important role. This paper concentrate on V2I communication, that is information exchange among the vehicles, this can be done with a Roadside Unit (RSU). The main function of RSU is to act as a data repository for information exchange among the vehicles to and from like traveller information, traffic information, accidents zones, etc. RSU is a standalone device that communicates with vehicles as well as with Communication networks. Deployment of RSUs was cost-effective, once we install, we cannot mobile the RSU Equipment, so the right way of placing RSU is very important. This paper focuses on and proposed a cost-effective RSU deployment strategy in the VANETs environment, the proposed strategy is based on principles of adaptive beamforming method, by applying these principles, we select an effective emplacement of RSU in different vehicular environment topology.

Keywords: VANETs, RSU, MUSIC, DOA

1. Introduction

With great enhancement in the field of vehicular ad-hoc networks, providing right information to the vehicle node is very important. In order to provide such right information, intelligent transportation system contribute its development.

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VANET used a technology called dedicated short-range communication, for exchanging date over the nodes [4]. In order do that a fixed defined infrastructure is made, which contains the two types of communication, they are On Board units and Road side unit [5, 18]. OBU is device which gathers the information like vehicle position and speed of vehicle details [16]. And this information helps to adjacent vehicles for better communication. Road side Unit (RSU) deploys along the road side, it acts as Base station, for sending information form one vehicle to another vehicle [6, 9], it also define the routing information for concern vehicle. It covers range of commination for better handling of vehicle node [12]. RSU provides various application information like traffic details, Internet to serve vehicles and with the V2I provide pedestrians information [10].

This paper contributed asa present a novel strategical method which makes the best deployment of RSU on highway segment and also minimal number of RSU deployment over the Urban areas. The remaining section organized as follows in section 2, explains Literature survey, in section 3, the related work, in section 4, explains the proposed method and in section 5, presents a simulation result. finally conclude the paper.

2. Literature Survey

In [7] Authors found that distributing information from RSU to vehicle is node is play an key role. For efficient transmitting information, they used game theory concept for selection of road side unit over the dynamically changing environment.in [15], author identified a method called depth-based approach, based on density they are going to find the selection of RSU. Kim et al [2], author found a new approach for selection of RSU, based on the real time data, by considering the downto map were converted to grid structure. In [19], based on real data from metro scenario, they consider the nodes of graph as traffic controller for finding the candidate location, so that number of vehicles coverage will increase more by each other from one RSU to another RSU and also considered installation cost.

In [3], it was suggested to place RSU with intersection of a location, it was done with graph theory over the considering the real data scenarios with urban environment. In [1], author was found the RSU placement with genetic algorithm, based on maximum number of roads covered, with this process found the best way of selection of RSUs in urban scenarios.In [17], in order to improve the deployment of RSU and reduce the minimum number of RSUs, used the concept of Max coverage based on threshold values, by that intersection of RSU were considered.In [8],it was proposed that with the help of dataset, analysed the probability of vehicles move over the route and calculate the no of entries and exit time of concerned vehciels , found the placement of RSU over there [13, 14, 11].

3. System Model

3.1. Direction of Arrival

3.1.1. Minnorm & ROOT Music

For Min-norm & ROOT MUSIC AOA assessment for a $M = 8$ element array with noise variance = .1, we use time averages instead of expected values by assuming ergodicity of the mean and ergodicity of the correlation. First solve the regular MUSIC problem, then Findmultinomial coefficients for root-MUSIC, and plot comparing the two methods.

Initially, we need to get the no of signal required for sampling process. Let us assumed as D. after that get the length of the samples.

calculate the K time samples of the signals for the number of arriving directions.

$$s = sqrt(\text{signal}) * \text{signal}(\text{randomn}(D, K))$$

calculate source correlation matrix with uncorrelated signals as

$$Rss = s * s'/K \tag{3.1}$$

calculate the K time samples of the noise for the no of array elements

$$n = sqrt(sig2) * randn(M, K) \tag{3.2}$$

calculate the noise correlation matrix (which is no longer diagonal)

$$Rnn = (n * n')/K \tag{3.3}$$

calculate the noise/signal correlation matrix

$$Rns = (n * s')/K \tag{3.4}$$

calculate the signal/noise correlation matrix

$$Rsn = (s * n')/K \tag{3.5}$$

combine all to get the array correlation matrix

$$Rrr = A * Rss * A' + A * Rsn + Rns * A' + Rnn \tag{3.6}$$

sorts the eigenvalues from least to greatest

$$[Y, Index] = sort(diag(Dia)) \tag{3.7}$$

calculate the noise subspace matrix of eigenvectors using the sorting done in the previous line

$$EN = V(:, Index(1 : M - D)) \tag{3.8}$$

calculate the matrix C

$$C = c1 * c1' \tag{3.9}$$

Then,
Find the coefficients for the root-MUSIC polynomial,
find the roots of the $2 * (M - 1)$ polynomial

$$rts = roots(cc) \tag{3.10}$$

find the angles associated with these root

$$angs = asin(angle(rts)/pi) * 180/pi \tag{3.11}$$

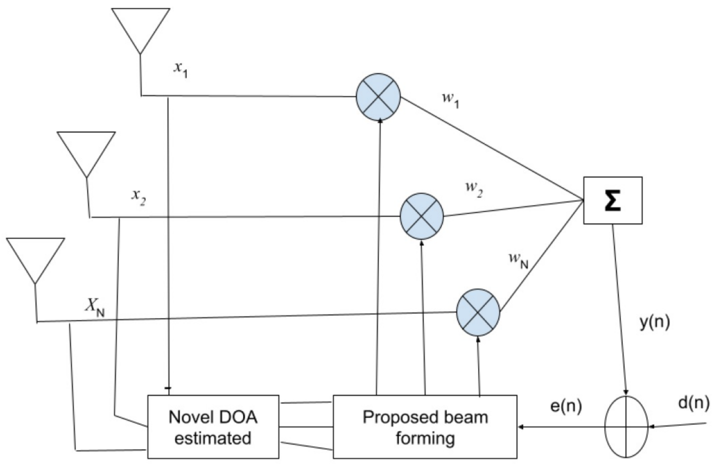

Figure 1: Proposed array system

3.2. Novel Beamforming Method

New novel work is a best in performance, time reducing in the beam forming and effectual and intelligent compared to other beam forming techniques.

This method iteratively finds the required association vector and required association matrix. It performs extremely fast convergence; However, this benefit comes at the cost of high computational complexity.

Thus,

$$R_{xx}(k) = \sum_{j=1}^{i} \alpha^{i-j} x(l) x^{-H}(l)$$
$$r(i) = \sum_{j=1}^{i} \alpha^{i-j} d^{*}(l) x(l) \tag{3.12}$$

α is forgetting factor.
start recursion relationship with correlation matrix is.

$$R_{xx}(k) = \alpha R_{xx}(k-l) + x(k) x^{-H}(k) \tag{3.13}$$

From above equation, desire signal is

$$w(k) = w(k-l) + g[(k)d^{*}(k) - x^{-H}(k) w(k-l)] \tag{3.14}$$

Recursive equation allows for easy updates of inverse of correlation matrix.
Determine the array factor for linear array using,

$$AF = AF + conj(ww(k)). * exp(l * (k-1) * 2 * pi * d * \sin(theta)) \tag{3.15}$$

4. Proposed Model for RSU Deployment

Deployment of RSUs in urban vehicular environment plays an important role. To implement these models, we analyze the various different environment topologies based on principle of Adaptive beamforming technique.

The following procedure will help us in deployment of RSUs

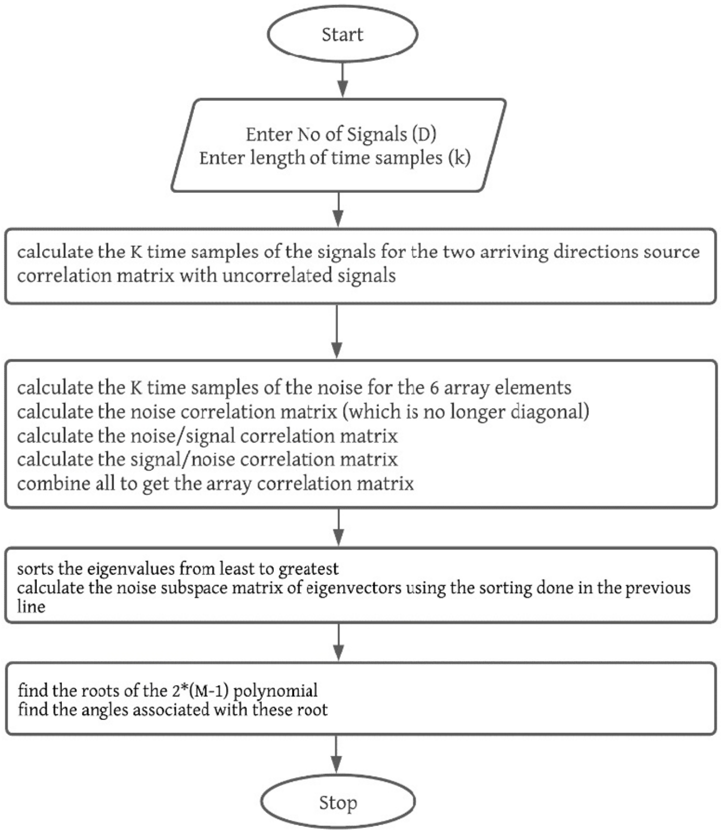

Figure 2: Process flow of DOA method

1. First Select the route and its vehicles over the concern routes.
2. Apply Two base station method for finding the direction of arrival of signal.
3. Analyze the direction of arrival of signal from various vehicles using MINNORM & ROOT MUSIC method.
4. Apply a novel beamforming method and finds the suitable SNR value.
5. Based on the SNR value of various vehicles over the route, we decided the right position of RSU deployment.

4.1. MINNORM & ROOT MUSIC Method

Process flow of Proposed DOA Method,

The above diagram 2 explains the process of finding the direction of arrival of signal from concerned Vehicle in urban areas. Initially let us assume we received a signals from the vehicles and it find the no of samples. Further it will moves to remaining steps and execute in sequence manner. Finally we found the desired direction of arrival of signal in degrees.

4.2. Novel Beamforming Method

For finding the SNR value of concerned vehicle, the given Process flow of proposed method will help.

With Novel adaptive beamforming algorithm, it was on the principle of gradient based approach. Finest way to supressing the shape of elliptical paraboloid is through the gradient method.

Error indication is,

$$e(i) = d(i) - [\overline{w}^H(i)\overline{x}(i)] \tag{4.1}$$

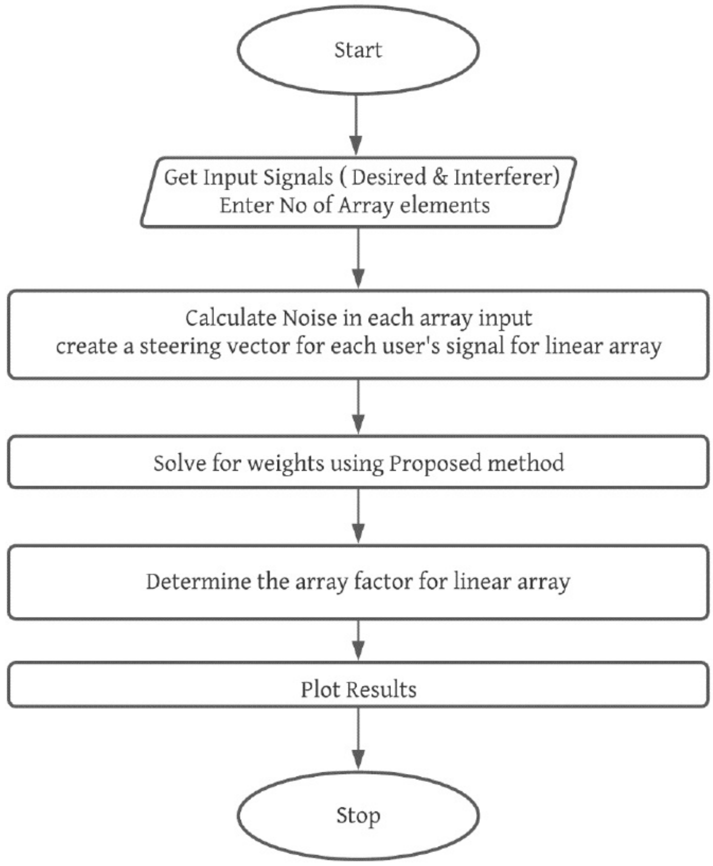

Figure 3: Process flow of Novel Beamforming method

Squared error is,

$$|e(i)|^2 = |d(i) - [\overline{w}^H(i)\overline{x}(i)]|^2 \tag{4.2}$$

Cost function is,

$$C(w) = D–2w_r^{-H} + w^{-H}R_x w \tag{4.3}$$

Where, $D = E[|d|^2]$
Proposed solution is,

$$w(i+1) = w(i) - \mu[R_x w - r] = w(i) - \mu e(i)x(i) \tag{4.4}$$

With above process flow 3 we can, find SNR value of concerned vehicle in various routes.

4.3. Position of RSU

$$y_s = x_s \tan\theta_i + (y_i - x_i \tan\theta_i) \tag{4.5}$$

Equating the line of position for the two $BSs, i = 1, 2$, and solving for x_s yields

$$x_s = \frac{y_2 - y_1 - x_2 \tan\theta_2 + x_1 \tan\theta_1}{\tan\theta_1 - \tan\theta_2} \tag{4.6}$$

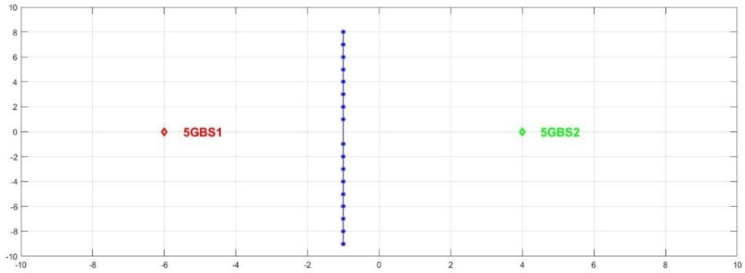

Figure 4: Without RSU Emplacement

Table 1: Route 1 Data values

S. NO	DOA	SNR	Position of RSU
Vehicle 1	57.99462	26.79	
Vehicle 2	54.46232	23.83	
Vehicle 3	50.19443	18.77	
Vehicle 4	45	21.53	
Vehicle 5	38.65981	26.81	(-2,4) and (0,4)
Vehicle 6	30.96376	26.76	
Vehicle 7	21.80141	26.19	
Vehicle 8	11.30993	21.9	
Vehicle 9	0	10.47	
Vehicle 10	348.6901	15.81	
Vehicle 11	338.1986	12.83	
Vehicle 12	329.0362	14.26	
Vehicle 13	321.3402	13.82	
Vehicle 14	315	12.86	
Vehicle 15	309.8056	12.94	
Vehicle 16	305.5377	16.303	
Vehicle 17	302.0054	19.63	

5. Simulation and Results

We designed and implemented novel work of with combined Beamforming Technique VANETs using MATLAB 2017 simulation tool, and the related results are displayed in below graphs. Simulated parameters are:

1. No of antenna elements in array antenna $M = 8$
2. Frequency band 5.9 GHz
3. Distance between antennas d =half wavelength
4. Signal arrival angle
5. AWGN variance is 0.1

Route 1 (Straight Road):

After analyzing the various SNR values of various vehicles, the best SNR vehicle value and its position in the route will be considered as the right emplacement of RSU over the environment.

After applying the proposed model, we got the below data value (1)

Route 2 (L shaped Road):

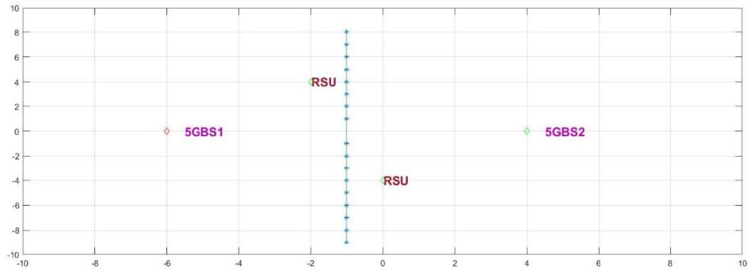

Figure 5: With RSU emplacement

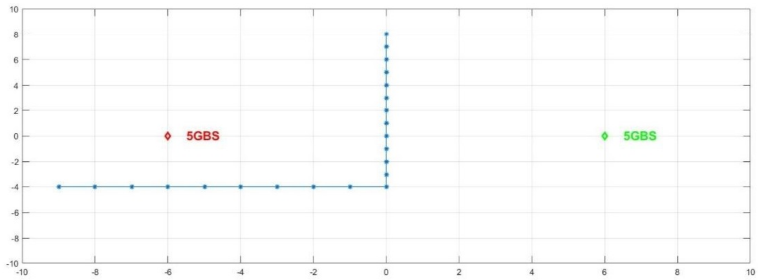

Figure 6: Without RSU Emplacement

After analyzing the various SNR values of various vehicles, the best SNR vehicle value and its position in the route will be considered as the right emplacement of RSU over the environment.

After applying the proposed model, we got the below data values (2)

6. Conclusion

We designed a cost-effective model for emplacement of RSU over the VANETs environment, which makes an efficient effective delivery of traveler information, traffic information, accidents zones etc., we verified through simulation that our model correctly predict the right emplacement of RSU. Future we can implement this work for routing techniques in 5G vehicular environment.

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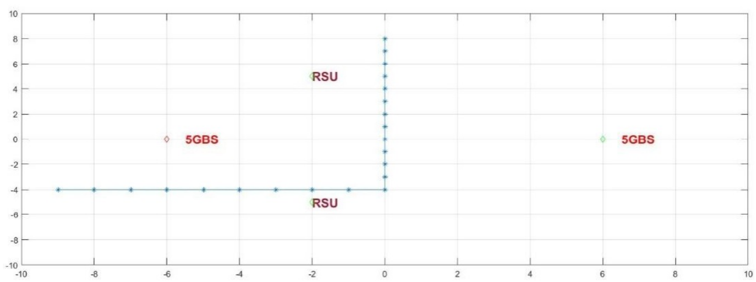

Figure 7: With RSU emplacement

Table 2: Route 2 Data values

S. NO	DOA	SNR	Position of RSU
Vehicle 1	53.1301	22.56	
Vehicle 2	49.39871	16.85	
Vehicle 3	45	21.33	
Vehicle 4	39.80557	26.61	
Vehicle 5	33.69007	26.9	
Vehicle 6	26.56505	27.42	(-2,5)
Vehicle 7	18.43495	21.61	
Vehicle 8	9.462322	25.55	
Vehicle 9	0	10.32	
Vehicle 10	350.5377	18.66	
Vehicle 11	341.5651	11.78	
Vehicle 12	333.4349	12.12	
Vehicle 13	326.3099	15.16	
Vehicle 14	321.3402	13.82	
Vehicle 15	315	12.86	
Vehicle 16	306.8699	14.56	
Vehicle 17	296.5651	20.16	

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