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Beyond Google's PageRank: Complex Number-based Calculations for Node Ranking

By K. Sugihara

Abstract- This study is focused on a proposed alternative algorithm for Google's PageRank, named Hermitian centrality score, which employs complex numbers for scoring a node of the network to overcome the issues of PageRank's link analysis. This study presents the Hermitian centrality score as a solution for the problems of PageRank, which are associated with the damping factor of Google's algorithm. The algorithm for Hermitian centrality score is designed to be free from a damping factor, and it reproduces PageRank results well. Moreover, the proposed algorithm can mathematically and systematically change the point of a node of a network.

Keywords: search engine, PageRank, damping factor, complex number, hermitian adjacency matrix.

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K.Sugihara

Abstract- This study is focused on a proposed alternative algorithm for Google's PageRank, named Hermitian centrality score, which employs complex numbers for scoring a node of the network to overcome the issues of PageRank's link analysis. This study presents the Hermitian centrality score as a solution for the problems of PageRank, which are associated with the damping factor of Google's algorithm. The algorithm for Hermitian centrality score is designed to be free from a damping factor, and it reproduces PageRank results well. Moreover, the proposed algorithm can mathematically and systematically change the point of a node of a network.

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I. INTRODUCTION

Google's Page Rank is a link analysis algorithm widely used by search engines to rank web page results. Page Rank assigns scores to sites based on popularity; that is, the more popular the page is, the higher is its assigned score. It utilizes hyper relationships modeled as a directed graph, and express them as an adjacency matrix using real numbers. Moreover, this algorithm incorporates a damping factor within the values of 0 to 1, for the generation of a strongly connected directed graph. However, there are problems associated with determining these specific coefficients. This study proposes an algorithm called Hermitian centrality score, which does not require a damping factor to produce results similar to those of Page Rank, and which can be developed systematically for a specific purpose. The method expresses link relationships between the nodes in a directed graph using the imaginary unit and only requires this graph to be weakly connected, although it applies to a non-weakly connected graph.

II. RELATED WORKS

Page Rank [1] [2] of Google's search engine has been a widely investigated algorithm [3], whereas Hermitian centrality score utilizes the Hermitian adjacency matrix that is a newly introduced idea in graph theory by Guo [4]. Sugihara [5] was the first to use the Hermitian adjacency matrix to score a node of a directed graph.

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III. PAGERANK

a) Definitions

Definition 1: A semi path is a collection of distinct nodes, v_1, v_2, \dots, v_n together with $n - 1$ links, one from each v_1v_2 or v_2v_1, v_2v_3 or $v_3v_2, \dots, v_{n-1}v_n$ or v_nv_{n-1} .

Definition 2: A path is a collection of distinct nodes, v_1, v_2, \dots, v_n , together with the links, $v_1v_2, v_2v_3, \dots, v_{n-1}v_n$.

Definition 3: A directed graph $G = (V, E)$ is called weakly connected if, for all nodes $v_1, v_2 \in V$ there exists a semi path between v_1 and v_2 .

Definition 4: A directed graph $G = (V, E)$ is called strongly connected if for all nodes $v_1, v_2 \in V$ there exists a path from v_1 to v_2 .

b) Page Rank algorithm

Page Rank has three characteristics [2], [6] that can be digested as follows. First, a page receives a high score when it has an inline from a node with a high score. Second, a page catches a high score when it has many inlines. Third, a page receives a high score when it has an inline from a node with few outlines. Thus, the selected outline to the page is important to obtain a high score. Page Rank considers the score of a node in a directed graph based on the nodes that have an outline to the node without taking into account a node that has an inline from the node.

The Page Rank scores of the nodes of a directed graph are defined as follows [7]. Let $|P_i|$ be the number of outlines from a node i . We define the $n \times n$ matrix H_{ij} as follows: $H_{ij} = 1/|P_i|$ if there is a link from node i to node j and equals 0 otherwise. We define the matrix S as follows using e^T to designate a row vector of all 1s. $S = H + \alpha((1/n)e^T)$, where $a_i = 1$ if node i has no outline and 0 otherwise. We define the matrix G as follows: $G = \alpha S + (1 - \alpha)(1/n)ee^T$. The PageRank scores are the elements of the normalized dominant left-hand eigenvector of G that corresponds to the real dominant eigenvalue, 1. The dominant eigenvalue is defined as the absolute maximum eigenvalue of a square matrix. The coefficient α in the equation is called the damping factor. We need this factor to ensure that the matrix G is a matrix of a strongly connected directed

graph. A square matrix A is irreducible if and only if its directed graph is strongly connected [8]. According to the Perron–Frobenius theorem, if $A \geq 0$ is irreducible, $r = \rho(A) > 0$, $r \in \sigma(A)$, and the multiplicity of the eigenvalue is 1. Here, $\rho(A)$ is the spectral radius of A , and $\sigma(A)$ is the spectrum of A [8]. Therefore, a real positive dominant eigenvalue exists. Also, this value is unique because the multiplicity is 1. Otherwise, a dominant eigenvalue cannot be determined. In this model, the damping factor, α , can be understood as a parameter that controls the proportion of time that a user follows the hyperlinks, as opposed to randomly jumping to new webpages. If, for example, $\alpha = 0.85$, then 85% of the time, the user uses the hyperlink structure of the Internet, and the other 15% of the time, s/he goes to a random new page [7].

c) Problems

PageRank currently faces the following problems.

i. Empirical Labor

The selection of a damping factor value is eminently empirical, and in most cases, the value of 0.85 proposed by Brian and Page is used [9]. With the damping factor value 0.85, the directed graph in Figure 1 has the ranking 3, 5 = 7, 4 = 6 = 9, 2, 1 = 8.

ii. Inconsistent Rankings

A network has inconsistent rankings when using different damping factor values [10]. An example of this case is shown in Figure 2. As stated in the abovementioned empirical labor problem, we do not know how the ranking of the nodes will be changed before we increase the damping factor from 0 to 1.

iii. Possible Use for Spam

A specific damping factor value could be used to create spam against a search engine [11].

iv. Fixed Top-Ranking Node

This problem means that the top-ranking node of a directed graph is fixed for all damping factor values from 0 to 1 even though we would like another node to be recognized as the top ranking. For example, in the directed graph in Figure 1, node 3 is the top-ranking node for all damping factor values from 0 to 1, as shown in Figure 2. However, we may choose that nodes 5 and 7 should be the top nodes because there is a path from node 3 to those nodes, and there is no path from nodes 5 and 7 to node 3.

IV. HERMITIAN CENTRALITY SCORE

Hermitian centrality score is based on eigenvector centrality [12] in social network analysis[13]. In the following part of this paper, first, we develop the algorithm of the Type I Hermitian Centrality Score.

Second, based on the Type I algorithm, we create the algorithm of Type II Hermitian Centrality Score. Type II algorithm is intended as an alternative to Page Rank.

a) Definitions

Definition 5: A node v_1 is reachable to a node v_2 if there is a path from the former

Definition 6: For a directed graph $G = (V, E)$, the Hermitian adjacency matrix H is defined in the following equation (1), using i as the imaginary unit [4]. This matrix is a Hermitian matrix because for all u and v , h_{uv} and h_{vu} are complex conjugates each other.

b) Advantage of the Hermitian adjacency matrix

An advantage of using the Hermitian adjacency matrix is that eigenvalues of it are always real numbers, because it is a Hermitian matrix. Moreover, the results of trials suggest that, if a directed graph is weakly connected, the absolute dominant eigenvalue, $|\lambda|_1$, of the graph's Hermitian adjacency matrix, H , is a positive number with a multiplicity of 1, a negative number with a multiplicity of 1, or a positive number with a multiplicity of 1 and a negative number with a multiplicity of 1. According to the results of the trials, these conditions are satisfied when we derive the Hermitian matrix H'' from H' using the method described below and when we create the Hermitian matrix H'''' from H'' with the procedure introduced subsequently in this paper. We select the positive eigenvalue, if the dominant eigenvalues include a positive and a negative real value.

c) Algorithm for the type I Hermitian centrality score

The algorithm for the type I Hermitian centrality score of a node of a directed graph is as follows. We use N to designate the number of all the nodes of the entire graph.

The algorithm is designed to be used for each weakly connected directed graph in the entire graph. Once we derive a score of the node of a weakly connected graph from the algorithm, we can compare it to the score of another node, which belongs to a different weakly connected graph, which is also derived by the algorithm.

Stage 1: Label the node with zero inlines at the origin of the longest path as node o .

Stage 2: If there are more than one nodes that satisfy the condition described above, add a dummy node and links from the dummy node to the nodes that satisfy the condition; the dummy node is designated as o .

Stage 3: Create the Hermitian adjacency matrix H of the weakly connected graph.

Stage 4: In H , convert each i element to $s(t + i)$ and each $-i$ element to $s(t - i)$, which derives H' . Here,

$$s = \sin\left(\frac{\pi}{2} \times \frac{1}{N}\right) \text{ and } t = \frac{1}{s} \times \cos\left(\frac{\pi}{2} \times \frac{1}{N}\right).$$

Stage 5: In H' each $s(t+i)$ is divided by the number of appearances of $s(t+i)$ in a row. Each diagonally corresponding $s(t-i)$ is divided by the same number, which creates H'' .

Stage 6: Solve the eigenequation $X = \frac{1}{|\lambda|_1} H'' X$ and

designate the solution $X = [x_1, x_2, \dots, x_o, \dots, x_n]^T$,

where x_o is the element corresponding to node O in Stage 1, and chose the solution so that x_o equals 1. Then, each element of $X = [x_1, x_2, \dots, x_o (= 1), \dots, x_n]^T$ is located on a complex plane, and is considered as a two-dimensional vector on the plane.

Stage 7: The type I Hermitian centrality score value of the node i is defined as $\{2\pi - \arg(x_i)\} \times |x_i|$.

Of note Stage 7 of the algorithm for defining the score of node i of a graph is the product of $2\pi - \arg(x_i)$, which is the angle in the clockwise direction from the real axis of the complex plane, and, $|x_i|$, which is the length of the 2-dimensional vector corresponding to the node on the complex plane; both terms derived from the eigenequation of H'' . In Stage 6, when node i has an inline from node j and an outline to node k , the 2-dimensional vector of node i is created as the composition of the 2-dimensional vector of node j rotated by $\frac{\pi}{2} \times \frac{1}{N}$ in the clockwise direction and the 2-dimensional vector of node k rotated by $\frac{\pi}{2} \times \frac{1}{N}$ in the counterclockwise direction. We need to convert i and $-i$ using s and t in Stage 4 to confine all converted 2-dimensional vectors of all nodes of any weakly connected graphs, which may be the entire graph itself, in the fourth quadrant, so that $\arg(x_i)$ in Stage 7 does not exceed 2π . Using coefficient s , we can maintain the length of the converted vector the same as that of the vector before the conversion. In Stage 5, we introduce divisions, which correspond to the number of appearances of $s(t+i)$ to estimate selected outlines. Namely, when node i has an inline from node j and node j has, for example, three outlines, the length of the 2-dimensional vector of node j becomes smaller by three times in the composition of the 2-dimensional vector that corresponds node i so that in the composition of the 2-dimensional vector of node i , the contribution of the 2-dimensional vector of node j is forced to be smaller. Using Stage 6, we set the 2-dimensional vector of node o on the real axis of the complex plane so that the result of the product as the score of the node equals 0.

In those abovementioned considerations, the type I Hermitian centrality score determines the score of a node by considering both of all the node that have an outline to the node and all the nodes that have an inline from the node.

d) *Experimental Evaluation of the Type I Hermitian Centrality Score*

We apply the abovementioned algorithm to the directed graph in Figure 1. In this figure, the entire directed graph is a weakly connected graph. According to Stage 1, node 1 is o because it has zero inlines, and it is on the longest path, i. e., that is 1, 2, 3, 4, 5 (or 1, 2, 3, 6, 7). In the weakly connected graph, each 2-dimensional vector x_i in Stage 7 is obtained by the following equation (2).

In Figure 3, we plot each complex number corresponding to each 2-dimensional vector x_i on the complex plane. Table 1 shows the type I Hermitian centrality score values of the nodes in Figure 1 and their ranking.

e) *Algorithm for the type II Hermitian centrality score*

We modify the algorithm of the type I Hermitian centrality score to create the type II Hermitian centrality score. The latter can mathematically and systematically change the point of a node of a directed graph, and, it can reproduce the result of Page Rank well. As in the type I, we use N to designate the number of all the nodes of the entire graph.

As in the type I algorithm, the algorithm is designed to be used for each weakly connected directed graph in the entire graph. Once we derive the score of a node of a weakly connected graph, we can compare it to the score of another node, which belongs to a different weakly connected graph, which is also derived by the algorithm.

The algorithm of the type II Hermitian Centrality Score:

Stage 1': In a weakly connected graph, label the nodes in it with zero in lines as $o_1, \dots, o_2, \dots, o_i, \dots, o_q$.

Stage 2': If the weakly connected graph does not have a node with zero in lines, add a dummy node to the entire graph and add links from the dummy node to all the nodes in the weakly connected graphs. The same dummy node is used for another weakly connected graph if this weakly connected graph also does not have a node with zero in lines.

Stage 3': For each weakly connected graph, induce subgraphs using the nodes that are reachable from o_1 and create the Hermitian adjacency matrix H from the subgraph of o_1 . The same processes are conducted for the remaining $o_2, \dots, o_i, \dots, o_q$.

Stage 4' : It is identical to Stage 4 in the type I algorithm.

Stage 5' : It is identical to Stage 5 in the type I algorithm.

Stage 6' : It is identical to Stage 6 in the type I algorithm.

Stage 7' : First, the tentative type II Hermitian centrality score of node i in the subgraph including o_1 is defined as $[k_2 + \{2\pi - \arg(x_i)\}] \times (k_1 + \frac{1}{M})$. Here, M is the multiplication of the number of outlines of each node, which precede the node, excluding the node itself. Second, for node i in the weakly connected graph, the final type II Hermitian centrality score is the sum of its scores from its every tentative score in every subgraph induced by all nodes that are reachable from each node with zero inlines in the weakly connected graph.

Of note k_1 is the parameter for the distance from the node with zero inlines. This distance is defined in terms of the angle from the real axis on the complex plane. As we increase the value of k_1 from 0, the score of the node increases depending on how far away the node is from the node with zero inlines.

Of note k_2 is the parameter for the selected inlines to the node. As we increase the value of k_2 from 0, the score of the node increases depending on how small the number of outlines of the nodes on the path from the node with zero inlines to the node, excluding the node itself.

Similar to Page Rank, the algorithm of the type II Hermitian centrality score determines the score of a node by considering all nodes that have an outlink to the node without considering the nodes that have an inline from the node. This point has been made possible by deploying $\frac{1}{M}$ in Stage7'. The deployment of $\frac{1}{M}$ is equivalent to eliminate the contribution from the nodes that have an outline to the node in the creation of the 2-dimensional vector of the node on the complex plane.

f) Experimental Evaluation of Type II Hermitian Centrality Score

i. Directed Graph in Figure 1: fixed k_1 and k_2

We calculate the type II Hermitian centrality scores of the nodes in the directed graph in Figure 1, by setting $k_1 = 1$ and $k_2 = 0$.

In Stage 1', nodes 1 and 8 are the nodes with zero inlines. According to Stage3', we use nodes 1, 2, 3, 4, 5, 6, 7, and 9, which are reachable from node 1 to create the first subgraph in Figure 4. We use nodes 3, 4, 5, 6, 7, 8, and 9, which are reachable from node 8 to constitute the second subgraph in Figure 5. We apply Stage 4', Stage 5', Stage 6', and the first part of Stage 7' on the first subgraph in Figure 1 to obtain and the following equation (3).

In Figure 6, we plot each complex number, which corresponds to each 2-dimensional vector x_i on the complex plane. Table 2 shows the tentative type II Hermitian centrality score values of the nodes in Figure 4.

Table 3 shows the tentative type II Hermitian centrality score values of the nodes in the subgraph in Figure 5, which are calculated by adopting Stage 4', Stage 5', Stage 6', and the first part of Stage 7'. Table 4 shows the final type II Hermitian centrality score values of the nodes of the weakly connected graph in Figure 1.

ii. Directed Graph in Figure 1: changing k_1 and k_2

For the directed graph in Figure 1, we converted k_1 and k_2 from 0 to 0.5 with the interval of 0.05. The type II Hermitian centrality score values of nodes 3 and 5 (the score of node 7) are shown in Figure7. Figure7 shows that when $k_2 = 0$, the point of node 5 is always higher than that of node 3; and if $k_1 = 0$, the score of node 3 is higher than that of node 5. The abovementioned results are obtained because k_1 is the parameter for the distance from the node with 0 zero inlines, and, k_2 is the parameter for selected inlines to the node. Here, the fixed top-ranking node problem of Page Rank with the directed graph in Figure 1 has been solved by the type II Hermitian centrality score.

The rankings by the type II Hermitian centrality score of the nodes from Figure 1 become the same as those of Page Rank when $k_1 = 0.9$ and $k_2 = 0.4$, as shown in Table 5.

iii. A larger network case

The directed graph in Figure 8 is composed of 60 nodes. The links between the nodes in the graph were created randomly and can be reproduced with the "set.seed(000)" for "rgraph(60, tprob=0.014)" command in the sna package for Linux R version 3.4.3. We apply the type II Hermitian centrality algorithm to the graph using the following parameters of k_1 and k_2 : 0 to 1 with the interval of 0.1. Then, we calculate spearman correlation coefficients between the scores by PageRank using the damping factor of 0.85 and the type II Hermitian centrality score values. The maximal value of the correlation coefficient is 0.9453585 at $k_1 = 0$ and $k_2 = 0$. Namely, the type II Hermitian centrality score can reproduce the result of PageRank well. The scatter plot of the parameters for the PageRank scores and type II scores is shown in Figure 9.

$$H_{uv} = \begin{cases} 1 & \text{if } uv \text{ and } vu \in E; \\ i & \text{if } uv \in E \text{ and } vu \notin E; \\ -i & \text{if } uv \notin E \text{ and } vu \in E; \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

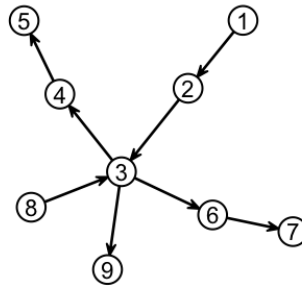


Figure 1: Directed graph

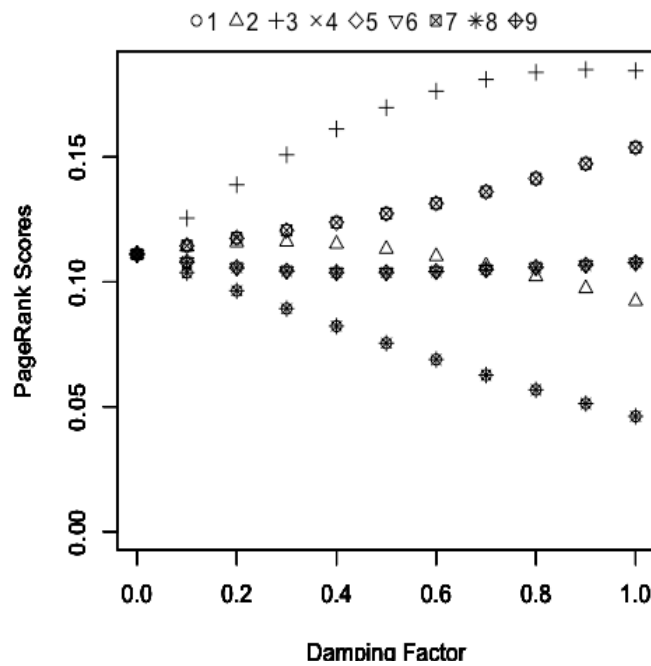


Figure 2: Rankings of the nodes of the graph with a changing damping factor value shown in Figure 1

$$X = \frac{1}{|\lambda|_1} H^T X \tag{2}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \end{bmatrix} = \frac{1}{|\lambda|_1} \begin{bmatrix} 0 & s(t+i) & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ s(t-i) & 0 & s(t+i) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & s(t-i) & 0 & \frac{s(t+i)}{3} & 0 & \frac{s(t+i)}{3} & 0 & \frac{s(t-i)}{3} & \frac{s(t+i)}{3} \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & s(t+i) & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & s(t-i) & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & 0 & 0 & s(t+i) & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & s(t-i) & 0 & 0 & 0 \\ 0 & 0 & \frac{s(t+i)}{3} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \end{bmatrix}$$

$$= \begin{bmatrix} 1.0000000 + 0.0000000i \\ 2.3399810 - 0.4126018i \\ 4.3655782 - 1.5889405i \\ 2.0577448 - 1.1880395i \\ 0.7660444 - 0.6427876i \\ 2.0577448 - 1.1880395i \\ 0.7660444 - 0.6427876i \\ 1.9255134 - 0.3395200i \\ 1.6932681 - 0.9776088i \end{bmatrix}$$

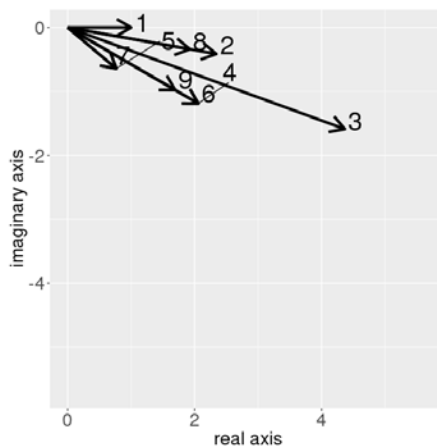


Figure 3: Complex plane plotting of 2-dimensional vectors of the nodes from Figure 1 focused on the fourth quadrant

Table 1: Type I Scores and Ranking of the node shown in Figure 1

Node	$2\pi - \arg(x_i)$	$ x_i $	Type I Score $\{2\pi - \arg(x_i)\} \times x_i $	Ranking
1	0.0000000	1.000000	0	7
2	0.1745329	2.376079	0.4147039584991	5
3	0.3490659	4.645751	1.6216732539909	1
4	0.5235988	2.376079	1.2441121131052	2
5	0.6981317	1.000000	0.6981317	4
6	0.5235988	2.376079	1.2441121131052	2
7	0.6981317	1.000000	0.6981317	4
8	0.1745329	1.955218	0.3412498676722	6
9	0.5235988	1.955218	1.0237497985384	3

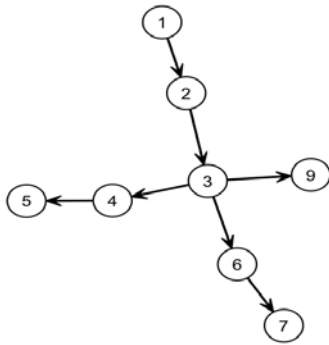


Figure 4: Nodes Reachable from Node 1 in Figure 1

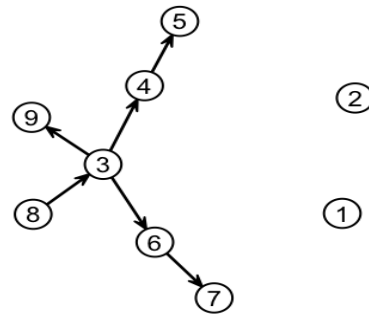


Figure 5: Nodes Reachable from Node 8 in Figure 1

$$X = \frac{1}{|\lambda|_1} H^* X \tag{3}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \end{bmatrix} = \frac{1}{|\lambda|_1} \begin{bmatrix} 0 & s(t+i) & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ s(t-i) & 0 & s(t+i) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & s(t-i) & 0 & \frac{s(t+i)}{3} & 0 & \frac{s(t+i)}{3} & 0 & 0 & \frac{s(t+i)}{3} \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & s(t+i) & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & s(t-i) & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & 0 & 0 & s(t+i) & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & s(t-i) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{s(t-i)}{3} & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \end{bmatrix}$$

$$= \begin{bmatrix} 1.0000000 + 0.0000000i \\ 2.1556467 - 0.3800987i \\ 3.5626452 - 1.2966968i \\ 1.8956439 - 1.0944505i \\ 0.7660444 - 0.6427876i \\ 1.8956439 - 1.0944505i \\ 0.7660444 - 0.6427876i \\ 0.0000000 + 0.0000000i \\ 1.5000000 - 0.8660254i \end{bmatrix}$$

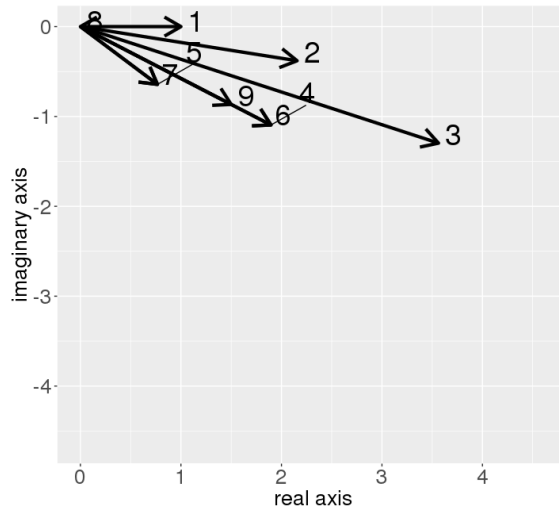


Figure 6: Complex Plane Plotting of 2-dimensional vectors of the nodes shown in Figure 4 focused on the fourth quadrant

Table 2: Tentative Type II Scores the node In Figure 4

Node	$2\pi - arg(x_i)$	Multiplication of out degree(s) of node(s) reachable to the node	Score $[k_2 + \{2\pi - arg(x_i)\}] \times (k_1 + \frac{1}{M})$: <i>k1 and k2 are set to 1 and 0, respectively.</i>
1	0.0000000	1	0.0000000
2	0.1745329	1	0.3490659
3	0.3490659	1×1	0.6981317
4	0.5235988	1×1×3	0.6981317
5	0.6981317	1×1×3×1	0.9308423
6	0.5235988	1×1×3	0.6981317
7	0.6981317	1×1×3×1	0.9308423
8	-	-	0.0000000
9	0.5235988	1×1×3	0.6981317

Table 3: Tentative Type II Scores of the nodes shown in Figure 5 Figure

Node	Score $[k_2 + \{2\pi - \text{arg}(x_i)\}] \times (k_1 + \frac{1}{M})$: k1 and k2 are set to 1 and 0, respectively.
1	0.0000000
2	0.0000000
3	0.3490659
4	0.4654211
5	0.6981317
6	0.4654211
7	0.6981317
8	0.0000000
9	0.4654211

Table 4: Final Type II Scores of the nodes shown in Figure 1

Node	Type II score $[k_2 + \{2\pi - \text{arg}(x_i)\}] \times (k_1 + \frac{1}{M})$: k1 and k2 are set to 1 and 0, respectively.	Ranking
1	0.000000	5
2	0.3490659	4
3	1.0471976	3
4	1.1635528	2
5	1.6289740	1
6	1.1635528	2
7	1.6289740	1
8	0.0000000	5
9	1.1635528	2

Table 5: Final Type II Scores of the nodes shown in Figure 1

Node	Type II Score of the nodes in Figure 1 k1 and k2 are set to 0.9 and 0.4, respectively.	Ranking
1	1.520000	5
2	1.851613	4
3	2.514838	1

4	2.062953	3
5	2.493468	2
6	2.062953	3
7	2.493468	2
8	1.520000	5
9	2.062953	3

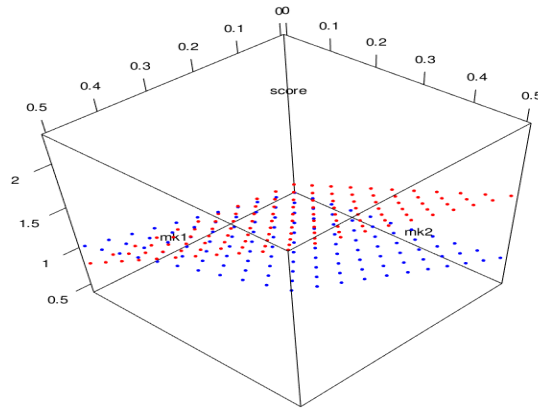


Figure 7: 3-Dimensional plot of the type II scores of the nodes shown in Figure 1 with changing k_1 and k_2 (Red: Node 3; Blue: Node 5)

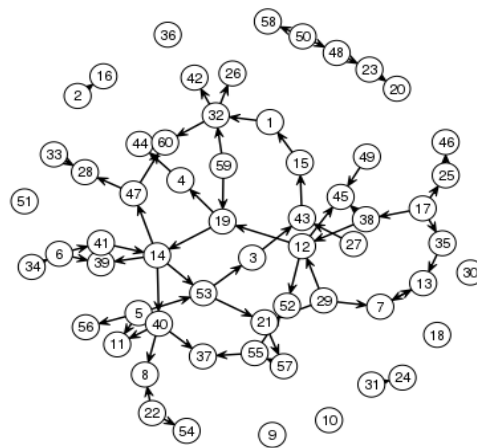


Figure 8: Directed graph of 60 nodes



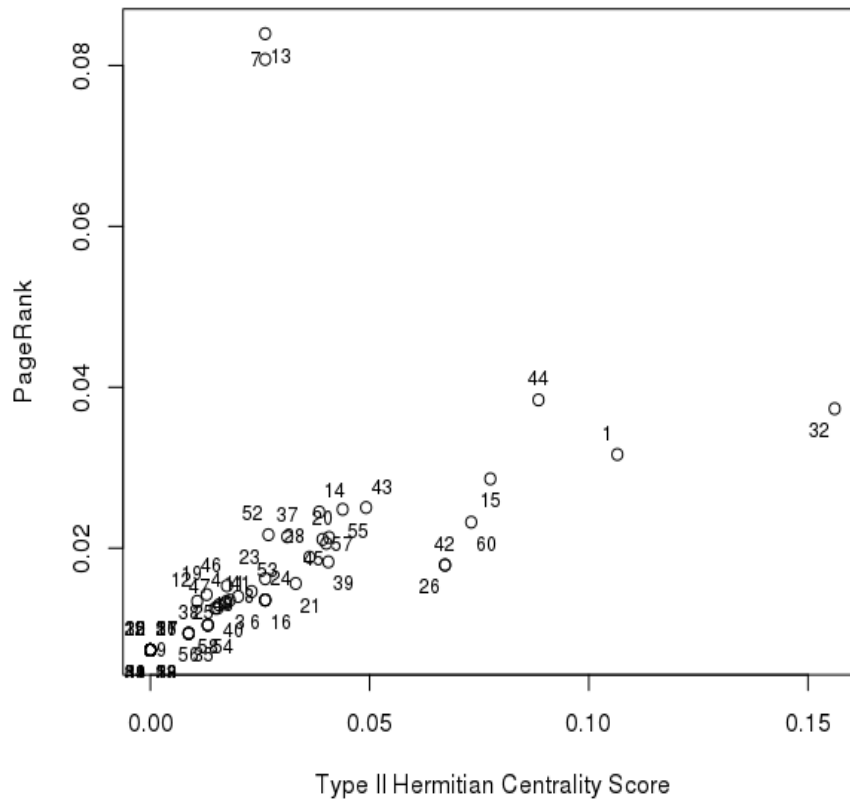


Figure 9: 2-Dimensional Plot of the Type II and PageRank Scores of the Nodes shown in Figure 8

V. CONCLUSION

This study showed that the four problems of Page Rank algorithm can be resolved with using the Hermitian centrality method, which does not require a damping factor. The novel algorithm effectively reproduces the ranking results of the Page Rank algorithm using 0.85 as the damping factor. Future research may use a sophisticated mathematical and systematic development of the proposed algorithm to achieve better scores.

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Architecture Considerations of LTE/WCDMA Wideband Power Amplifier for Efficiency Improvement

By Abdulraqeb Abdullah Saeed Abdo, Jie Ling & Pinghua Chen

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GJCST-E Classification: C.2.m



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Architecture Considerations of LTE/WCDMA Wideband Power Amplifier for Efficiency Improvement

Abdulraqeb Abdullah Saeed Abdo^α, Jie Ling^σ & Pinghua Chen^ρ

Abstract- An enhanced architecture for a broadband power amplifier (PA) for LTE and WCDMA handsets using In GaP/GaAs hetero-junction bipolar transistor (HBT) process is presented. A two-stage PA solution adopting switchable driver-stage amplifier without employing input switch is proposed to reduce loss and help with power efficiency improvement. Furthermore, in order to enhance the power-added efficiency (PAE) at the low output power level, a two-chain amplifying structure in parallel has been implemented. For wideband 1.71-1.98GHz, the fabricated PA shows >27dB of Gain and >38% of PAE with <80mA of quiescent current (Icq) at the output power (Pout) of 28dBm for high-power mode operation, as well as >16dB of Gain and >13% of PAE with <20mA of Icq at the Pout of 17dBm for low-power mode operation. The system power usage efficiency are obviously enhanced with the presented two-stage dual-chain PA architecture.

I. INTRODUCTION

As more and more cellular communication services are developed in recent mobile terminals, the multi-mode multi-band power amplifiers (PAs) is required to cramp multiple bands into a single front end [1-3]. Besides, to accommodate higher data rate of the leading WCDMA and LTE signals and extend the battery life of the handsets, high linearity and efficiency are as two most stringent specifications for the design of modern broadband PA [4,5]. Generally, the cellular PA is designed to operate with significant back-off for high linearity, but at the same time, this will decrease the power efficiency remarkably [7]. Therefore, various techniques have been presented for efficiency improvement [8-11]. This work, based on cost and integration considerations, introduces a novel broadband two-stage PA architecture which can minimize the degradation of linearity and efficiency, and at the same time, satisfy the system gain requirement. Furthermore, a two-chain parallel-amplifier structure is simultaneously realized to improve the power added efficiency (PAE) while the PA is operating in back-off by disabling one of the chains.

II. CIRCUIT ARCHITECTURE CONSIDERATIONS

Figure 1. (a) depicts a wideband three-stage PA structure. With this configuration, the system gain specification of 27dB is extremely easy to be achieved even though the insertion loss (IL) of the input switch is around 1.5 dB while the linearity and efficiency would be degraded owing to the extra stage and dc consumption. To improve the PA's linearity and efficiency, two-stage solution seems to be a better choice, however, it is difficult to satisfy the gain requirement in wideband system when only employing two-stage PA architecture with 1.5dB IL of input switch. If there is a two-stage PA solution where the input switch can be removed, then it is possible to meet the gain spec for LTE/WCDMA systems. Based on this idea, we presents a two-stage architecture with switchable driver stage, as shown in Figure 1 (b), the input of the first driver stage is connected to the Band 1/2 RF input pin while the input of the second one is linked to Band 4 RF input pin, both outputs are connected to the input of the second power stage. Depending on the logic voltage level applied to the bias circuits, one of the two switched driver stages is activated for different RF input paths. This solution can not only help with the linearity and efficiency enhancement due to the absence of additional stage, but also reduce losses and improve integration as an input switch using extra GaAs pHEMT or SOI process is not required anymore.

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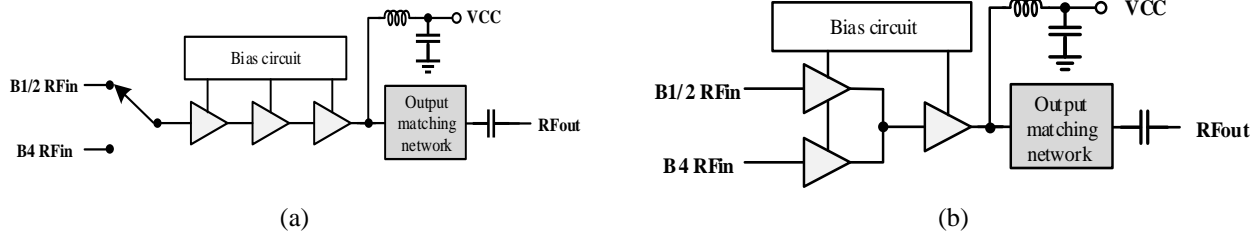


Figure 1: (a) Three-stage PA solution with input switch; (b) Presented two-stage PA solution with switchable driver stages

Furthermore, in view of the trade-off between efficiency and linearity, a Mid-Class AB operation is selected for the first stage (driver stage) of the presented PA, whereas a Deep-Class AB dc bias is set for the second stage (power stage). Nonetheless, even with this arrangement, the efficiency of the PA decreases as the input signal decreases in power. At these lower power levels, the PA's operating points are lowered further away from its saturation point, which leads to severe degradation of the PAE. To achieve high efficiency over a wide range of input power level, a two-stage broadband PA architecture with switchable driver-stage amplifier adopting dual-chain strategy have been developed, as shown in Figure.2. Either driver stages or

power stage is composed of two-chain hetero-junction bipolar transistor (HBT) amplifiers with identical emitter areas. The two driver-stage amplifier chains for Band1/2 and Band4, respectively, have a same emitter area of $280\mu\text{m}^2$ and $350\mu\text{m}^2$, and the two power-stage amplifier chains have a same emitter area of $2000\mu\text{m}^2$. In the high-power mode (HPM), two-chain HBT amplifiers are activated for high output power and the PA can obtain a P1dB of 28dBm, while for the low-power mode (LPM), only the main-chain amplifiers are enabled to achieve a P1dB of 17dBm and the aided-chain ones are disabled to reduce the bias voltage and quiescent current, and thus benefitting the efficiency improvement in the presence of low input power level.

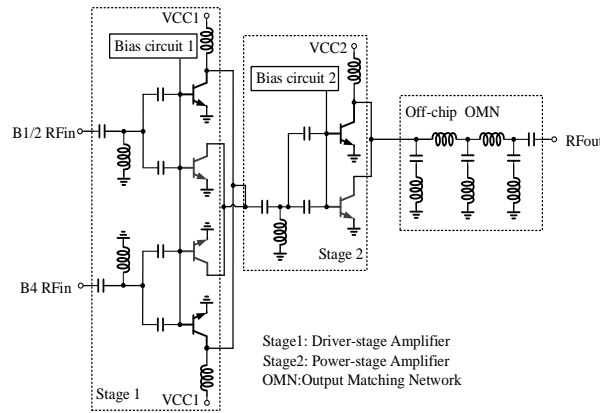


Figure 2: Simplified schematic of presented two-stage dual-chain PA architecture

In addition, at wo-section LC low-pass filter (LPF) type network is utilized for output matching to realize broadband, and a second harmonic traps are merged into the output matching network to achieve better harmonic suppression performance.

III. FABRICATION AND MEASUREMENT

Figure. 3 illustrates the micrograph of the fabricated PA module with a size of $1300 \times 1100\mu\text{m}^2$, which in cludes a PA die with the presented two-stage dual-chain strategy in an In GaP/Ga As HBT process.

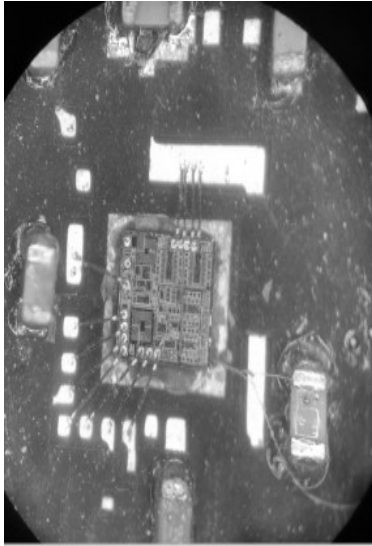


Figure 3: Micrograph of fabricated PA module

The measured linear Gain (S21) in the high power and low power modes are plotted in the Figure.4. Over the frequencies ranging from 1.7 to 2.0GHz, the PA obtains S21 ranging from 27.7 to 29.2dB. It can be well observed that the presented two-stage solution with switchable driver stages is able to satisfy the system gain requirement.

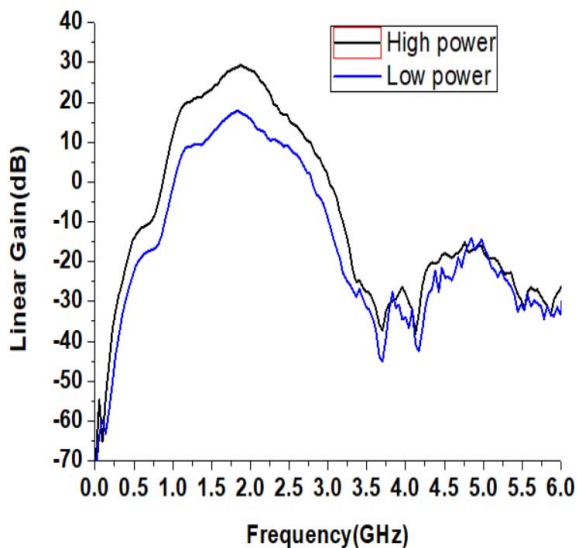


Figure 4: Measured linear Gain (S21) in the high power and low power modes

Figure 5: shows the measured output power in the high power and low power modes at 1.9GHz. At the input power (Pin) of 1dBm in the HP M and LPM, the PA gains an output power of 28.1 and 17.6dBm, respectively.

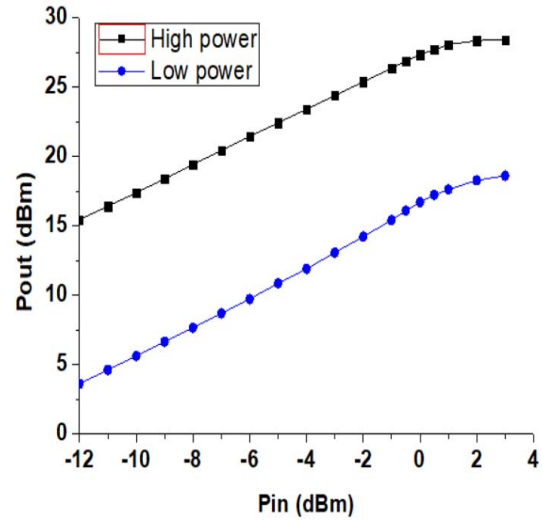


Figure 5: Measured Pin versus Pout at 1.9GHz in the high power and low power modes

Figure. 6 describes the measured over gain for the two modes at 1.9GHz. At the output power (Pout) of 28dBm in the HPM, the PA delivers the power gain of 27.05dB, while in the LPM, the power gain of 16.7dB is realized at the Pout of 17dBm.

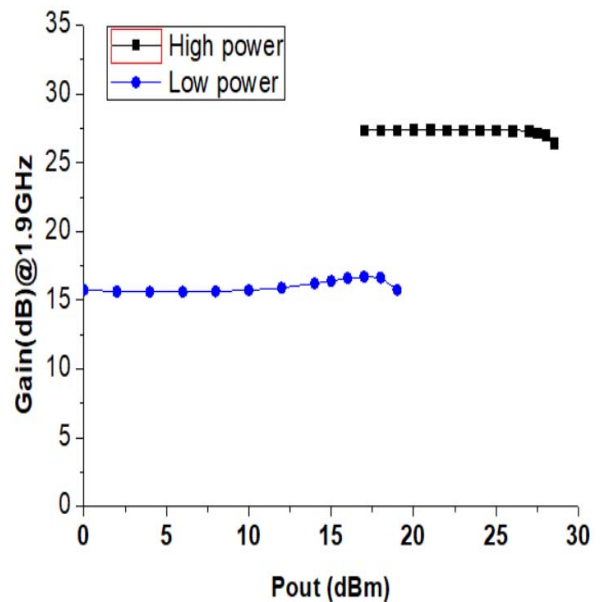


Figure 6: Measured Gain versus Pout at 1.9GHz in the high power and low power modes

Figure 7: illustrates the measured PAE performance or responding to the different power modes at 1.9GHz. The PA delivers achieves the PAE of 38.15% at the output power (Pout) of 28dBm in the HPM, where the PAE of 13.3% is obtained at the Pout of 17dBm in the LPM. These results indicate around 4.5-5%

superior PAE with the new dual-chain PA strategy, in contrast to the traditional single chain one only with HPM.

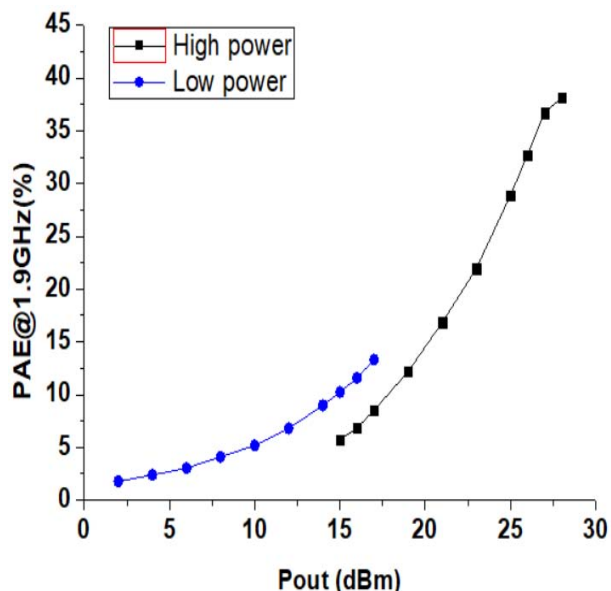


Figure 7: Measured PAE versus Pout at 1.9GHz in the high power and low power modes

Lastly, aquiescent current (Icq) of roughly 80mA for HPM and 20mA for LPM have been gained with continuous-wave power measurement. The presented PA module reveals favorable and competitive efficiency performance in the broadband WCDMA/LTE handset applications.

IV. SUMMARY

A two-stage dual-chain In GaP/Ga As HBT power amplifier module with switchable driver stages is implemented and demonstrated for multi band multi mode WCDMA and LTE handsets applications. The wideband PA module shows a 38% of PAE at 28dBm output power, and 13% of PAE at 17dBm output power at 1.9GHz, which demonstrates that the presented architecture benefits the power usage efficiency improvement of the PA when operating in the back-off.

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Issues of Topology Based Reactive Routing Protocols in Vanets

By Dumpala Prasanth & Dr. L. RamaParvathy

Saveetha School of Engineering

Abstract- Late years fast development in the quantity of vehicles on street has expanded, So there is a requests for progressing correspondence. Vehicular specially appointed systems (VANETs) has turned out to be a significant hot research region over the most recent couple of years. Because of their qualities, for example, high unique topology and unsurprising portability, Route determination and the executives are one of the key issues in Vehicular Ad hoc Networks (VANETs). So they draw in a lot of consideration on research point of view. This paper, portrays a few issues and difficulties of Route choice and the board in VANETs.

Keywords: *vanet, routing protocols, manet.*

GJCST-E Classification: *C.2.1*



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Issues of Topology Based Reactive Routing Protocols in Vanets

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Keywords: vanet, routing protocols, manet.

I. INTRODUCTION

VANETs are utilized in vehicular space to give Intelligent Transport System (ITS). Remote correspondence is the methods by which clients of the system can speak with one another utilizing radio waves rather than customary links. In numerous viewpoints, remote systems are profitable than wired systems like free development inside the system, not having to lay bunches of links, minimal effort for system foundation, expanded versatility and so forth.

VANETs are a fastidious sort of Mobile Ad Hoc Network, (MANET), in which vehicles go about as hubs and every vehicle is outfitted with correspondence abilities which are interrelated to frame a system. The principle aim of dig into VANETs is the upgrading the vehicle wellbeing utilizing between vehicular correspondence (IVC). VANETs have in excess of a couple of various angles contrasted with MANETs, in that the hubs move with high velocity as a result of which the topology changes quickly. The correspondence in these sorts of systems are in the middle of vehicles to streets and vehicles to vehicles and entombs street correspondence is utilized for improving the security and to arrive at the objectives of VANETs. The accompanying figure gives the possibility of correspondence in VANETs.

II. TYPES OF COMMUNICATION IN VANETS

Fascinatingly the utilizations of WSNs were developed definitely, Such as getting to web through vehicles; sharing of data among vehicles, traffic data and so forth. So productive steering convention ought to be utilized to stay away from deferral, bundle drops and diminish continuous connection breaks. Presently a day's vehicles on streets are intensely expanded, because of the lively idea of VANETs connects between two vehicles would stay for a brief timeframe because of this correspondence would get defer which diminishes organize execution. Existing methodologies utilized E-TX, interface termination time, rate estimations and flooding strategies for building up a solid course among source and goal. In any case, considering just lapse time and rate components couldn't yield better outcomes in such a case that a hub with high termination time with least strength won't build up an appropriate correspondence.

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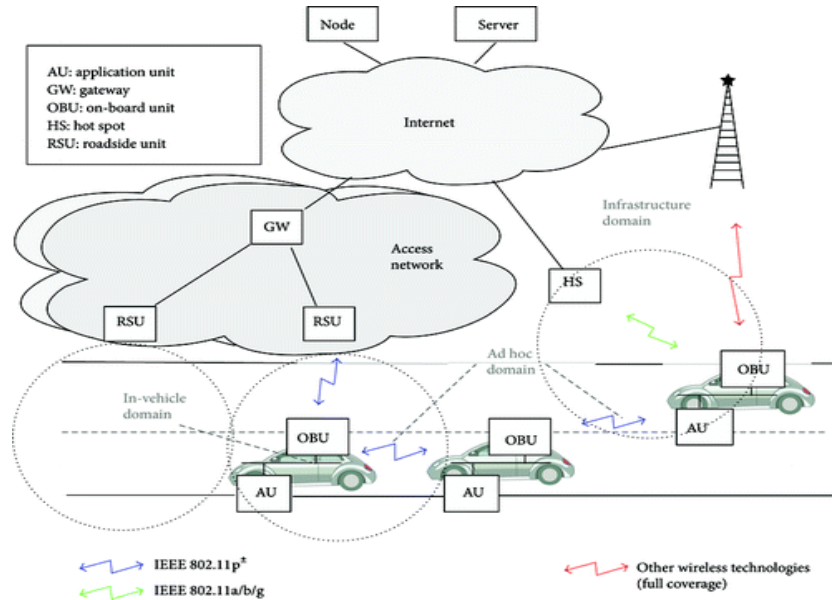


Fig.1: Architecture of VANET

III. OVERVIEW OF ROUTING PROTOCOLS IN MOBILE AD HOC NETWORKS

There are many directing conventions which have been proposed for specially appointed systems. In MANET no fixed system topology is utilized. In this manner, portable hubs receive any runtime topology because of their own unique conduct. What's more, there exists not in any case single technique for steering in MANET, as system is made at runtime. MANET gives such sort of remote correspondence in which the hubs are versatile. Moreover, MANET additionally encourages such environment to the versatile hubs in which they can interface whenever anyplace so as to convey among themselves. A few new handheld gadgets have been acquainted that have the office with associate with different gadgets and can likewise convey for trading information among them [23]. Effective conveyance of information among different hubs is outlandish without the steering conventions. So steering conventions for MANET is one of the difficult territories because of its dynamic and impromptu nature.

Many steering conventions have been grown so far to contend with unexpected changes that may emerge because of nature of the systems. Course revelation, course upkeep and abrupt change in the topology are the significant obstructions for steering conventions in MANET.

Because of these issues a few directing conventions have been built up that can meet the dynamic idea of specially appointed system. These diverse steering conventions are named as topology based directing. Further, in this section we center

around topology based directing conventions. These conventions and their sorts were widely contemplated so as to make a decision about their appropriateness in VANET.

a) Topology based routing

Several MANET routing protocols have used topology based routing approach. Topology based routing protocols use link's information within the network to send the data packets from source to destination [24]. Topology based routing approach can be further categorized in to three groups:

- Proactive routing
- Reactive routing
- Hybrid routing

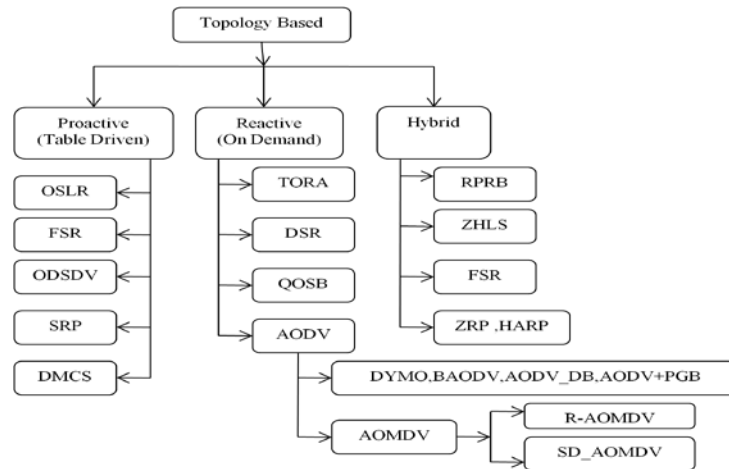


Fig. 2: Topology based routing algorithms

i. Proactive routing protocol

This convention is otherwise called a table driven convention and every hub keeps up a directing table will comprises of the data of steering to each hub in the system. Since the hubs are portable, they keep on the changing their area. It kept up the directing tables which are intermittent or at whatever point a change

happens, are refreshed give various proactive steering conventions. It contrast in the different territories like number of directing table will kept up and how the progressions are proliferate in the system. progressions are proliferate in the system.

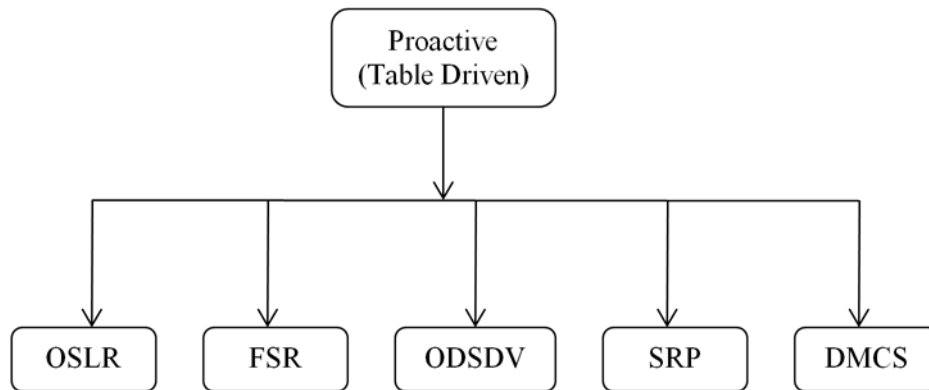


Fig.3: Proactive routing algorithms types

There is no course identification in this, since the goal course is put away out of sight, yet there is an issue in this convention. That it gives low inertness to an ongoing application. Steering table is developed and is kept up inside a hub. It prompts the protection of inactive ways, which will prompts the decreasing in the accessible data transmission. In these Proactive directing conventions the tables refreshing intermittently and sends the data starting with one hub then onto the next. This steering conventions additionally called as table driven conventions because of its temperament. Predominantly there are two kinds of updates accessible in proactive conventions occasional update and activated update because of broadcasting these

refreshing tables will waste power and transfer speed in the system [8].

ii. Reactive routing protocols

Reactive routing opens a route only when it is necessary for a node to communicate with another node. It maintains only the routes that are currently in use, thereby reducing the burden on the network.

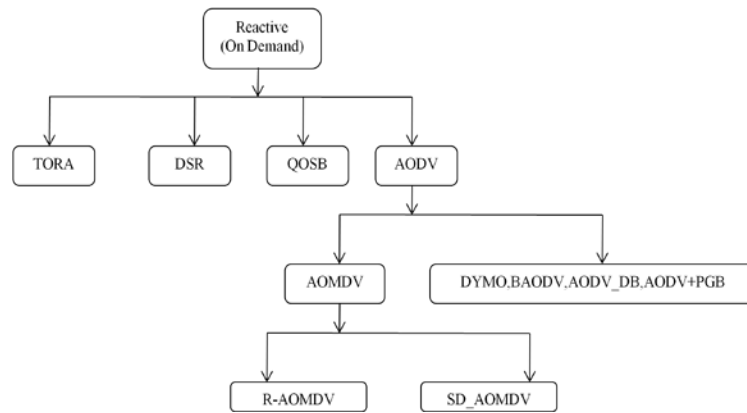


Fig.4: Reactive routing algorithms types

Information Engineering and Applications in which the question parcels are overflowed into the system for the way search and this stage finishes when course is found. These conventions are called as on-request steering conventions as they occasionally update the directing table, when Reactive steering comprises of course disclosure stage g Protocols for VANET, Journal of certain information is there to send. The different kinds of responsive steering conventions are AODV, DSR and TORA.

iii. Ad Hoc On Demand Distance Vector Routing - AODV

Ad Hoc on Demand Distance Vector Routing (AODV) [22] is a case of unadulterated responsive steering convention. AODV has a place with multihop sort of receptive directing. AODV steering convention works absolutely on interest premise when it is required by system, which is satisfied by hubs inside the system. Course revelation and course upkeep is additionally done on interest premise regardless of whether just two hubs need to speak with one another. AODV chops down the need of hubs so as to consistently stay dynamic and to ceaselessly refresh steering data at every hub. As such, AODV keeps up and finds courses just when there is a need of correspondence among various hubs.

AODV utilizes an effective strategy for steering that decreases system load by communicating course disclosure instrument and by progressively refreshing directing data at each middle hub. Change in topology and circle free directing is kept up by utilizing latest steering data lying among the moderate hub by using Destination Sequence Numbers of DSDV.

AODV Route Discovery

Route revelation is one of the most significant attributes of any convention in remote correspondence. The requirement for fundamental course revelation

emerges when a source hub needs to speak with a specific goal hub so as to advance information bundle. AODV uses course disclosure by communicating RREQ to all its neighboring hubs. The communicated RREQ contains addresses of source and goal hubs all together recognize those specific hubs for whom course has been requested. RREQ likewise contains source and goal hubs grouping numbers to keep up late crisp course data from source to goal and the other way around. Besides, RREQ likewise contains communicate ID and a counter [22], which tallies how frequently RREQ has been created from a particular hub. At the point when a source hub communicate a RREQ to its neighbors it procures RREP either from its neighbors or that neighbor(s) rebroadcasts RREQ to their neighbors by augmentation in the bounce counter. In the event that hub gets different course demands from same communicate ID, it drops rehashed course demands to make the correspondence circle free.

RREQ is produced from one source towards various goals so as to reach at specific goal. In the event that RREP isn't gotten by the source hub, it naturally arrangements turn around way to the source hub. A turn around way is settled just when every hub keeps the record of its neighbor from which it gets the RREQ. Invert way is utilized to send an answer to source hub, if any middle hub doesn't fulfills the RREQ, in addition switch way is agreed to just the restricted timeframe [22].

Every single middle of the road hub put away the specific goal succession number data and contrast it and the RREQ goal arrangement number. On the off chance that RREQ arrangement number is more prominent than or equivalent to put away grouping number of the halfway hub. At that point the RREP is produced to source hub following a similar course from goal hub to source hub. This technique is otherwise called the forward way disclosure [22]. What's more, along these lines a course is found for two hubs that need to convey.

iv. *Dynamic Source Routing DSR*

Introduction of DSR

Dynamic Source Routing convention (DSR) [8], intended for multi-jump remote specially appointed systems. This convention comprises of two tasks "Course Discovery" and "Course Maintenance" that makes it self-designing and self-arranging. DSR steering convention deal with the system with no brought together director or foundation. In course revelation this convention finds for the courses from source hub to goal.

In DSR, information bundles put away the steering data of every single transitional hub in its header to reach at a specific goal. Steering data for each source hub can be change whenever in the system and DSR refreshes it after each change happen [8]. Transitional switches don't have to have directing data to course the passing traffic, yet they spare steering data for their future use. Fundamental reason to create DSR was to decrease the overhead on the system and planning self sorting out and self designing convention to help MANET

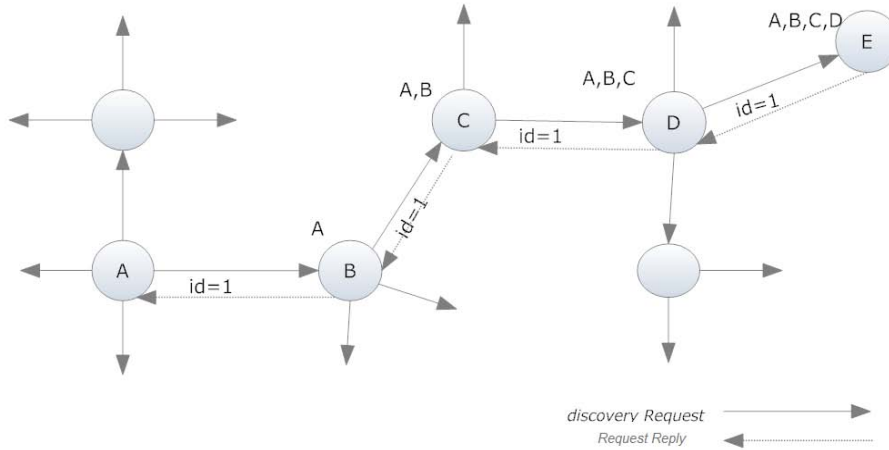


Figure 5: DSR Route Discovery [8]

In figure 5, hub "A" begins revelation procedure to discover the course to hub "E". So hub "A" called initiator and hub "E" is called target. At the point when course disclosure begins, initiator sends "revelation demand" to hubs that are inside its remote range. The disclosure solicitation contains initiators, target's and course data. In the beginning, course record is set to exhaust by the initiator. At the point when any hub gets the disclosure demand, it checks the objective data. On the off chance that recipient isn't target itself it add it's data to the course record and forward the disclosure solicitation to all hubs in the remote range. Be that as it may, when the objective hub gets the revelation demands it send the solicitation answer with conclusive course data containing the total middle of the road way. The objective hub can send the solicitation answer utilizing its course reserve or by switching the request or revelation demand. Consequently along these lines DSR find the course from source to goal.

Haas and Pearlman [20] proposed a half and half steering convention and named it as ZRP (Zone directing convention). The need of these conventions emerges with the inadequacies of proactive and responsive steering and there is request of such convention that can resolve on interest course revelation with a predetermined number of course look. ZRP limits the scope of proactive directing strategies to neighboring hubs locally, anyway ZRP utilizes responsive steering to look through the ideal hubs by questioning the specific system hubs all inclusive as opposed to sending the inquiry to every one of the hubs in system. ZRP utilizes "Intrazone" and "Interzone" directing to give adaptable course disclosure and course support in the various specially appointed conditions.

v. *Hybrid Routing*

Hybrid directing consolidates qualities of both receptive and proactive steering conventions to make steering progressively adaptable and proficient [21]. For the most part half breed steering conventions are zone based; it implies the quantity of hubs is partitioned into various zones to make course revelation and support increasingly dependable for MANET.

Interzone directing performs course disclosure through receptive steering convention all around while intrazone directing dependent on proactive directing so as to keep up exceptional course data locally inside its own directing extent [20]. The general normal for ZRP is that it decreases the system overhead that is brought about by proactive steering and it likewise handles the system postpone that is brought about by responsive directing conventions and perform course disclosure all the more effectively.

The downside of ZRP is that it isn't intended for such situations in which the hubs conduct is exceptionally powerful and fast changes in topology, for example, VANET. As it were we can say this steering convention is explicitly intended for such systems where hubs are not profoundly portable and system size is rely upon predetermined number of hubs. Unadulterated proactive or responsive directing conventions can be reasonable somewhat in an exceptionally unique condition like VANET when contrasted with Hybrid steering.

IV. OVERVIEW OF ROUTING PROTOCOLS IN VANETS

a) GPSR: Greedy Perimeter Stateless Routing for Wireless Networks

GPSR settles on eager sending choices utilizing data about a switch's quick neighbors in the system topology. At the point when a parcel arrives at a district where insatiable sending is unthinkable the calculation recoups by steering around the edge of the locale. By keeping state just about the nearby topology, GPSR scales preferred in per-switch state over most limited way and specially appointed directing conventions as the quantity of system goals increments. Under portability's incessant topology changes, GPSR can utilize nearby topology data to discover right new courses rapidly

i. Greedy Forwarding

In this sending procedure information parcels know the physical situation of their goal. As the originator knows the situation of its goal hub so the eager locales/jumps are chosen to advance the bundles to the hubs that are nearer to their goal. This procedure rehashes until the parcel effectively conveyed to wanted goal. Closest neighbor's physical position is assembled by using beaconing calculations or basic signals. At the point when a neighboring hub advances bundle to nearer area to goal, the sending hub get a signal message that contain IP address and position data. At that point it refreshes its data in the area table. In the event that sending hub doesn't get reference point from its neighboring hub inside a particular time span, it expect that either neighbor neglects to advance bundle to area closer to goal or neighbor's isn't in its radio range. So it expels its entrance from area table [17]. The significant bit of leeway of insatiable sending is that it holds current physical situation of sending hub. Along these lines by utilizing this technique all out separation to goal turns out to be less and bundles can be transmitted in brief timeframe. Other than its favorable circumstances there are not many downsides of this system for example there are a few topologies utilized in

it that restrains the parcel to move to a particular range or good ways from the goal. Moreover, this technique bombs when there are no nearer neighbors accessible to goal.

ii. Perimeter Forwarding

Border sending is utilized where covetous sending comes up short. It implies when there is no next jump nearest neighbor to the goal is accessible then border sending is utilized. Edge sending utilizes hubs in the void areas to advance bundles towards goal. The border sending utilized the correct hand rule. In "right hand rule" [17], the voids districts are misused by crossing the way counter clockwise way so as to reach at explicit goal. At the point when a parcel forward by source hub, it sent in counter clockwise bearing including goal hub until it again came to at the source hub. As per this standard every hub required to advance bundle around the void district and each edge that is crossed are called border. Edges may cross when right hand standard discovers edge that are encased in the void by using "heuristic methodology" [17]. Heuristic has a few disadvantages other than it gives greatest arrive at capacity to goal. The downside is that it expels without thought of those edges which are rehashed and this may cause the system parcels. To maintain a strategic distance from this disadvantage another methodology is embraced that is portrayed beneath.

iii. Planarized Graph

When two or more edges cross with each other in a single graph is called as planar graph. "Relative Neighbourhood Graph" and "Gabriel Graph" [17] are two types of planar graphs used to remove the crossing edges. Relative neighborhood graph is defined as, when two edges intersect with radio range of each other and share the same area. For example, x and y are the two edges that share the area of two vertices x and y. The edge x, y are removed by using Relative Neighbourhood Graph because another edge from x towards v is already available.

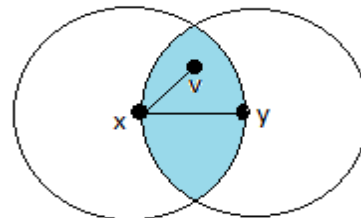


Figure 6: Example of Relative Neighborhood Graph [17]

Gabriel Graph is used to remove only those crossing edges which are in between the shared area of two nodes having the same diameter as the other nodes have. Figure 5 depicts Gabriel Graph.

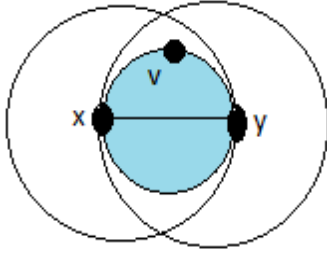


Figure 7: Example of Gabriel Graph [17]

Figure 7 shows that the midpoint diameter is less than the diameter of node x or node y. Thus the edge from the x, y cannot be removed. So there is less network disconnection in the GG as compared to RNG.

b) Position Based Routing

The exceptionally portable and dynamic nature of VANET, where hubs move extremely quick and changes its area oftentimes, popularity for such steering technique that can manage the earth of such system. These requests the analysts to utilize places of hubs so as to give effective correspondence from source to goal. Such technique in which topographical places of hubs are utilized to perform information steering from source to goal is called position based directing.

Position based steering accept that every hub know about its physical/geographic situation by position deciding administrations or by GPS deciding administrations. Every hub has the information of source, goal and other neighboring hubs. As contrasted and topology based steering, position based directing has the extra data about each taking an interest hub which is relevant in VANET, that extra data is accumulated through GPS. Position based steering gives jump by-bounce correspondence to vehicular systems. A position based directing convention comprises of some significant segments, for example, "beaconing", "area administration and servers" and "recuperation and sending procedures" [28, 25].

Beaconing

A hub advances parcel with the current physical position and the remarkable id. In the event that a hub gets reference point from its neighbor's, at that point it refreshes its data in it's area table. Along these lines beaconing is utilized to assemble data about

it's neighbor hub's in one-jump neighbor or hub's next bounce neighbor.

Area administration and servers

At the point when a hub doesn't have current physical situation of a particular hub in its area table or need to know current physical situation of a particular hub then area administration helped to discover current situation of a particular hub [25]. To follow down the current physical situation of an ideal hub, the hub will sends area question with the one of a kind ID to the ideal hub, arrangement number and absolute number of bounces. The neighbor's will answer for this message until wanted hub found and whenever wanted hub lies among close to neighbor's of the mentioned hub then it will reple with its current physical position message. Along these lines beginning hub updates wanted hub physical position data in the area table.

V. KEY CHALLENGES

Contrasting and MANETs, the a few highlights of VANETs require diverse correspondence ideal models, and remote correspondence frameworks [34]. For instance, arrange associations isn't steady for quite a while period. To improve the exhibition of correspondence, analysts have examined the compelling utilization of accessible foundation, for example, roadside units and cell systems. Albeit couple of explicit difficulties of VANETs have been survived, many key research difficulties have been illuminated halfway [34]. In this manner, specialists need to work further for tackling these difficulties. In the accompanying discourse, we will condense a portion of the key difficulties.

a) Throughput

Throughput is the normal number of effectively conveyed information bundles on a system hub or correspondence arrange. In words throughput portrays as the absolute number of got bundles at the goal out of all out number of transmitted parcels [1]. Throughput is determined in bytes/sec or information bundles every second. The reproduction result for throughput is demonstrates the absolute gotten bundles at goal in KB/Sec, numerically throughput is appeared as pursues:

$$\text{Throughput (bytes/sec)} = \frac{\text{Total number of received packets at destination} * \text{packet size}}{\text{Total simulation time}}$$

b) Packet Drop

Bundle drop demonstrates the quantity of information parcels that couldn't arrive at goal effectively. The explanation behind parcel drop may emerge because of clog, broken equipment and line flood and so on. Bundle drop will influences the system

execution by expending time and more transmission capacity for resending a parcel. Lower parcel drop rate demonstrates higher convention execution

c) Routing Protocols

Despite the fact that analysts have exhibiting numerous powerful steering conventions and

calculations, for example, intellectual MAC for VANET and voracious traffic-mindful directing, the basic test is to plan great steering conventions for VANETs correspondence with high portability of vehicles and high unique topology [33]

d) *Connectivity*

The control the board of system associations among vehicles and system among vehicles and frameworks is the most significant issue of VANETs correspondence [36]. The Primary test in structuring of vehicular correspondence is to give great defer execution under the imperatives of vehicular velocities, dynamic topology, and channel transmission capacities [37].

e) *Cooperative Communication*

VANETs as a sort of cloud called versatile processing cloud (MCC), and in [15] the creators present a broadband cloud in vehicular correspondence. Along these lines, the collaboration between vehicular mists and the Internet mists in the setting the executives of vehicular applications has turned into a basic test to scientists

f) *Mobility*

Portability is the standard of topology change rapidly in vehicular systems. In addition, the portability examples of vehicles on a similar street will show solid connections [38]. In [29], the creators address the possibility that portability assumes a key job in vehicular convention plan and displaying.

VI. CONCLUSION

In this paper, we have present the engineering of VANETs, including, correspondence types and system segments. At that point we examine parts of VANETs research issues in directing, this paper presents the vehicular impromptu systems from the exploration viewpoint, covers essential design, basic research issues, and general research strategies for VANETs, and gives an extensive reference on vehicular specially appointed systems.

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A Methodology for the Significant Unification of Boolean Logic and Wide- Area Networks

By Arunavo Dey & Nahid Anwar

Abstract- The implications of robust methodologies have been far-reaching and pervasive. After years of natural research into operating systems, we demonstrate the understanding of cache coherence. Here we confirm that write-back caches can be made wearable, per- mutable, and heterogeneous [21].

GJCST-E Classification: C.2.5



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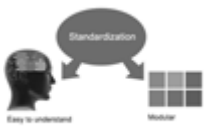
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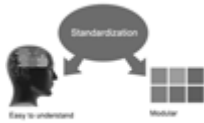


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14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	C-D	E-F
<i>Abstract</i>	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
<i>Introduction</i>	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
<i>Methods and Procedures</i>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
<i>Discussion</i>	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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