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New Algorithm to Handle Routing with Load Balancing in Wireless Networks Using EERNN

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A B S T R A C T

In this paper, static wireless network load balance algorithm is proposed, that use only optimal paths from point-to-point to achieve good load balance. This algorithm based on Enhanced version of Elman Recurrent Neural Network (EERNN) to make load balance decision depended on two metrics (traffic load on node and probability of link failure). This algorithm make good work in terms of both metrics simultaneously. Also, this algorithm use only local information. The execution of the proposed algorithm is compared with ERNN based on (traffic load on node and probability of link failure).

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Introduction

In (2004), J. Gao and L. Zhang studied routing in wireless networks that use all shortest paths to making good performance by reducing latency and reaching good load balance. They conclude that these algorithms only use local information and can work with dynamic change and mobility [1].

In (2007), A. Rostamizadeh ,L.Popa, C.Papadimitriou, I.Stoica and R.Karp, addresses the problem of balancing the traffic load in multi-node wireless networks they show that the optimal the routing scheme can be expressed in terms of geometric optics and computed by linear programming [2].

In (2010), V.Hoang, M.Ma, and H. Harada, proposed new multi-paths routing scheme for the Internet access in wireless mesh networks using multiple access routers. They try to enhance the network work by suggesting a scheme for load balancing, this scheme called Reactive Load Balancing. The proposal produced a little of benefits to wireless mesh networks such as load balancing among access routers, throughput enhancement, effective soft-handoff, etc. [3].

In (2011), A. Shastri and R. Dadhichl , studied a very important problem of how multi hops
Organize them into an ad-hoc network. They study heuristics for cluster formation and show that the resultant work has the best possible forwarding index asymptotically. taking a communication model that is derived from that of Bluetooth. They see that it is very useful for load balancing by means of minimizing the load of the cluster head (Master) hop and this maximizes the life time of the cluster head hop [4].

In **(2012),** K.Magade, Abhijit and M.Potey, suggested new methods for load balance in a wireless network organized in star topology. They proposed power control methods that maximize system throughput. These stratigies commonly take the approach of directly controlling the user-AP association by deploying proprietary client software or hardware. In these methods, APs broadcast their load levels to devices via modified beacon messages and each device chooses the least-loaded AP [5].

In (2015), M. Shaohui and C. Xiangqian , proposed gateway load balancing method depends on the QOS, which is fallen into switchable load balancing method. Their results show that the suggested method can enhance integration of heterogeneous network throughput, minimize business latency and packet loss rate, with strong robustness to make network load balancing and to make a balanced use of network resources [6].

In (2015), C. Zhao, H. Yao, C. Qiu, and L. Shi, presented a multi-controller load balancing system called Hybrid Flow in software-defined wireless networks , which depends on the method of distribution and centralization and designs a double threshold approach to evenly allocate the load [7].

Also, in (2015), S. Prabhavathi, A. Subramanyam and A. Rao, proposed a novel routing agent for routing optimization and load balancing that uses standard radio and energy model to compute energy optimization, the prime task of a new agent is to collect the aggregate data to the base station [8].

Elman Recurrent Neural a Network

Elman Neural Network (ERNN) is a type of partial recurrent neural network, this neural network consists of two-layer back propagation networks with an additional feedback connection from the output of the hidden layer to its input layer. The usage of this feedback path is that it allows ERNN to recognize and generate temporal patterns and spatial patterns. This means that after training, interrelations between the current input and internal states are processed to produce the output and to represent the relevant past information in the internal states [9].

Figure 1 displays the structure of a simple ERNN, the results from hidden units are used to calculate the output of the network and all are kept as "additional inputs" (called context unit) , which will be used once the network is worked later.

Figure 2 represent the internal learning method of ERNN by the error of back-propagation algorithm. We can notice that training such a network is not straight forward since its output depends on the inputs and also all previous inputs to the network [9].

The number of hidden and context units is n. The function f is a unipolar continuous (sigmoid) activation function defined below:-

$$f(v_i) = \frac{1}{1+\exp\left(-\lambda v_i(k)\right)}$$

Where:

$v_i(k) = w^t x$, w is a weight vector and x is an input vector.

Suggested model

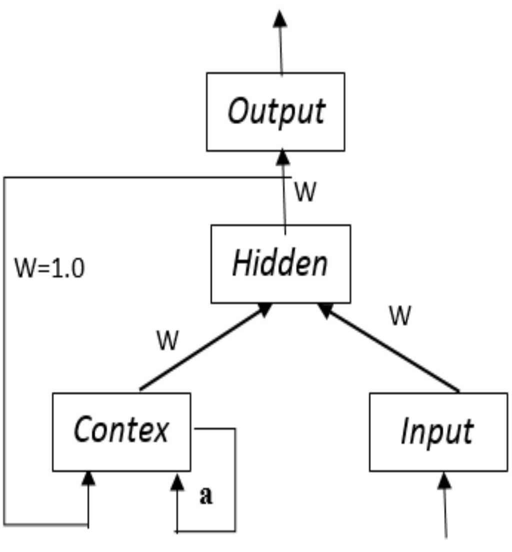

Figure 1. The Structure of the ERNN

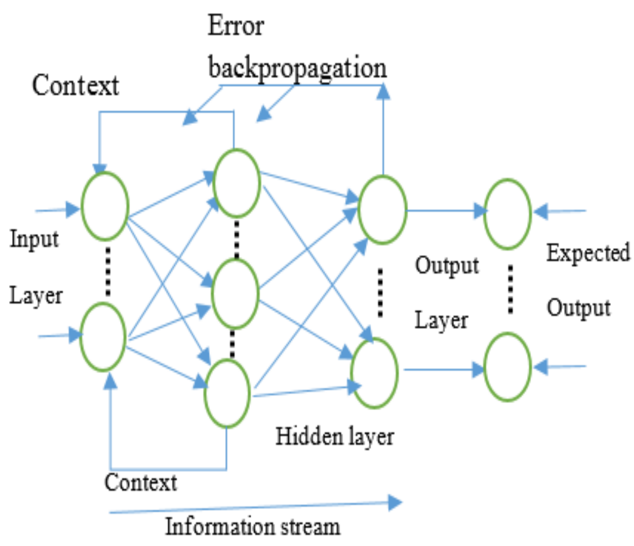

Figure 2. Internal Process Analysis of ERNN

The suggested method introduces a modern model that can perform static load balance between two nodes in wireless networks, based on two metrics (traffic load on node and probability of link failure). However the primary goal of this paper will be to accomplish much better load balance while sending the data from source node to destination node in wireless networks. In the current paper a new algorithm will be suggested that will make load balance between source and destination node using enhanced version of Elman recurrent neural network (EERNN), Figure (3) shows the scheme for the proposed method.

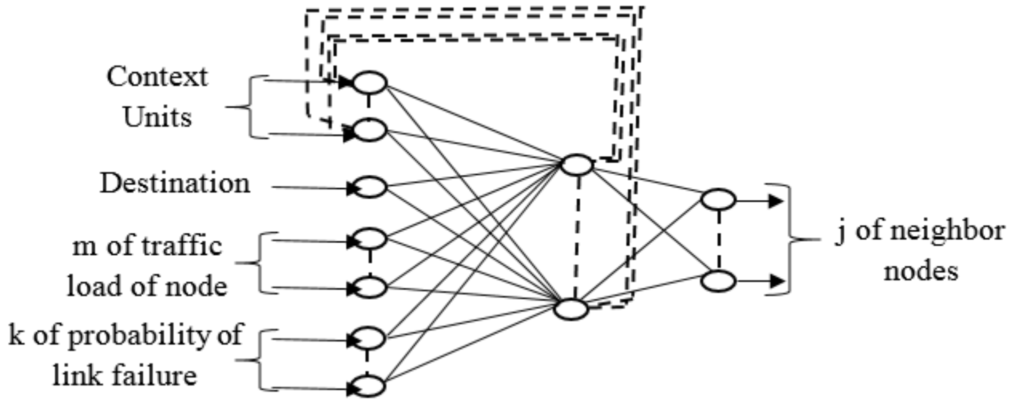

Figure (3): proposed recurrent neural network

This algorithm designed to solve load balance problem in wireless networks based on (EERNN). This recurrent neural network has (n+m+k+1) inputs, they are destination, (m of traffic load on nodes, k of probability of link failure) of neighbor nodes, n of context units, and j outputs (list of neighbor nodes that has minimum probability of link failure) as shown in Figure (3), where j is a number that represents the best neighbor nodes to the current node (source) that reaches the destination node in wireless network.

The output of recurrent neural ordered begins from the best neighbor node, which is the node that has minimum probability of link failure regardless of traffic load on the node, but when two nodes have same probability of failure on the link that connected it with source node or the difference between of them (0.05) the recurrent neural network will be choose the node that has minimum traffic load as best node, then choose another node as second one and making load balance between of them. (Note that the recurrent neural network will be choose all nodes equal in probability or close up in (0.05), not just two nodes).

The wireless network includes such recurrent neural network at each node. The node has information about probability of link failure and traffic load on nodes for neighbor nodes for transmission packets to it. As a result the recurrent neural network restrict all neighbor nodes that reaches the destination node with minimum probability of failure. At the beginning, the recurrent neural network determines all neighbor nodes that equal in link failure or close up in (0.05), then the node (source) select these neighbor nodes for sending a packets to destination node(uses these nodes in order for balancing the load (i.e. packets) between of them).

Simulation results

To test the proposed algorithm, this is applied to an example of wireless network as in Figure (4). The implementation of the simulation has been worked using C++ programming language.

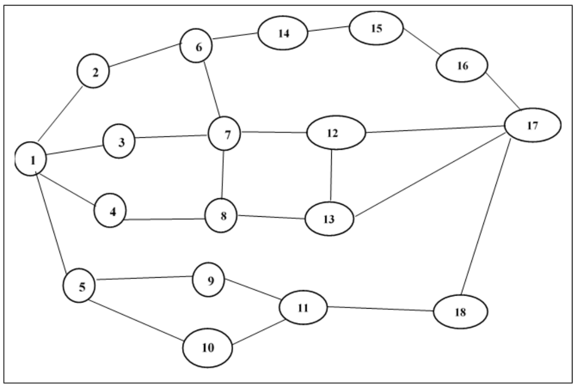

Figure (4) Wireless Network (WN) [10]

The activation function used in recurrent neural networks is a sigmoid function as in equation (1). The number of inputs, outputs, context units and hidden units of this recurrent neural network are described in table (1). In this Table m is the number of neighbor nodes, k is the number of links that connect the current node with neighbor nodes, and j is the number of neighbor nodes. The number of context unit and hidden units not necessary to be equal, because the input to each context unit is feedback from all hidden units (note that the benefit of context units is to duplicate the speed of training to the recurrent neural network).

For recurrent neural network, the training sets and the test sets are prepared. The training set consists of the inputs of recurrent neural network (m of traffic load on nodes, k of probability of link failure) and desired output which is all neighbor nodes for the current node that reaches to the destination node. In the training stage, random values between – 0.5 and 0.5 are used as initial weights of connections of recurrent neural network. The recurrent neural network is trained on 90 training sets with the back propagation algorithm for wireless network (WN).

For any set, the training is continued until the mean squared error (MSE) becomes acceptable, the value of MSE that used in this method is (0.1e-6) for the wireless network (WN). The value of learning rate (η) equal to (0.9) and momentum rate (α) equal to (0.5) these values are selected by trial and error.

Then, testing the performance of this recurrent neural network is performed on the trained sets, and on other test sets which are unseen before. For example, assume that at a given time the metrics that shown in Table (2) are seen on (WN). Table (3) shows the results of testing on (WN).

Through the testing of the proposed recurrent neural network, the results show its good performance on the other sets, the success rate for this recurrent neural network was 96%.

From the simulation results, the following points are noticed:-

-The number of inputs to recurrent neural network is not constant; it is changed depending on the number of neighbor nodes for the source (current) node that reach to the destination node.

-The recurrent neural network use information about neighbor nodes only to make load balance decision.

Table (1) the number of inputs, outputs, context units and hidden units of the proposed recurrent neural networks

Number of inputs	Number of outputs	Number of context units	Number of hidden units
n+m+k+1	j	20	15

Table (2) probability of link failure, traffic load on node, for WN.

Link No.	Probability of link failure	Node No.	Traffic load on node (Mbyte)
(1-2)	0.03	1	100M
(1-3)	0.02	2	110M
(1-4)	0.07	3	120M
(1-5)	0.05	4	200M
(2-6)	0.01	5	100M
(3-7)	0.01	6	100M
(4-8)	0.02	7	90M
(5-9)	0.03	8	80M
(5-10)	0.04	9	70M
(6-7)	0.03	10	80M
(6-14)	0.03	11	70M

(7-12)	0.02	12	70M
(7-8)	0.02	13	75M
(8-13)	0.03	14	150M
(9-11)	0.02	15	120M
(10-11)	0.07	16	150M
(11-18)	0.09	17	70M
(12-17)	0.03	18	80M
(12-13)	0.09		
(14-15)	0.06		
(15-16)	0.04		
(16-17)	0.02		
(18-17)	0.08		
(13-17)	0.01		

Table (3) some of testing results using recurrent neural network for wireless network (WN)

No. sample	S	D	Real ordering of neighbor node for the source that access to the destination	The output of recurrent neural network
1	1	17	[2 3]	[2 3]
2	7	17	[12 8]	[12 8]
3	1	7	[2 3]	[2 3]
4	7	9	[12 8]	[12 8]

As a result for making routing decision with load balance from source node (1) to destination node (17) as an example, the following steps will be followed:

Step1: the best neighbor nodes to the node (1) are (2) and (3), the decision of recurrent neural network is make load balance between these nodes.

Step2: for node (3) there is just one node (7).

For node (2) there is just one node (6).

Step3: for node (6) the best neighbor node is (7).

For node (7) the best neighbor nodes (12 and 8).

Step4: for node (12) the best one is (17) and this is destination node.

For node (8) there is just one neighbor node (13) for this node the best neighbor node is (17) and this is the destination node.

At the end the traffic travelling from node (1) to node (17) on these paths

(1→ 2→6→7→12→17)

(1→2→6→7→8→13→17)

(1→3→7→12→17)

(1→3→7→8→13→17)

Balancing load between these paths will be increasing the speed of travelling the information.

Conclusion

The proposed algorithm used Enhanced Elman Recurrent Neural Network (EERNN) to solve the load-balancing problem in wireless network which depending on (traffic load on node and probability of link failure). The back propagation is used to train the network and testes for example. The performance of network is better when combined the EERNN with neural network to solve load traffic in the network.

References:

[1] Gao, J., & Zhang, L. (2006). Load-balanced short-path routing in wireless networks. *IEEE transactions on Parallel and distributed systems*, *17*(4), 377-388.

[2] Popa, L., Rostamizadeh, A., Karp, R., Papadimitriou, C., & Stoica, I. (2007, September). Balancing traffic load in wireless networks with curveball routing. In *Proceedings of the 8th ACM international symposium on Mobile ad hoc networking and computing* (pp. 170-179). ACM.

[3] Hoang, V. D., Ma, M., & Harada, H. (2010). Multi-paths routing with load balancing for Internet Access in Wireless Mesh Networks. *International Journal of Wireless and Mobile Networks*, *2*(1), 65-75

[4] Verma, S. S., Kumar, A., & Patel, R. B. (2018). QoS oriented dynamic flow preemption (DFP) in MANET. *Journal of Information and Optimization Sciences*, *39*(1), 183-193.

[5] Dadhich, R., & Shastri, A. Load Balancing In Wireless Ad-Hoc Networks With Low Forwarding Index. *International Journal of Wireless & Mobile Networks (IJWMN)*, *3*(1), 40-48.

[6] Chaudhary, D. D., Nayse, S. P., & Waghmare, L. M. (2011). Application of wireless sensor networks for greenhouse parameter control in precision

[7] Joshi, S., & Jayswal, A. K. (2012). Energy-Efficient MAC Protocol for Wireless Sensor Networks-A Review. *International Journal of Smart Sensors and Ad Hoc Networks*, *1*(4), 107-112.

[8] Xiangqian, C. H. E. N., Shaohui, M. A., & Kai, Z. (2015). Load Balancing Algorithm Based on QoS Awareness Applied in Wireless Networks. *International Journal of Future Generation Communication and Networking*, *8*(4), 173-186.

[9] Yao, H., Qiu, C., Zhao, C., & Shi, L. (2015). A multicontroller load balancing approach in software-defined wireless networks. *International Journal of Distributed Sensor Networks*, *11*(10), 454159.

[10] Prabhavathi, S., Subramanyam, A., & Rao, A. A. (2015). Routing Optimization with Load Balancing: an Energy Efficient Approach. *International Journal of Advanced Networking and Applications*, *7*(1), 2582.

[11] Al Smadi T.A , etc, High-Speed for Data Transmission in GSM Networks Based on Cognitive Radio, American Journal of Engineering and Applied Sciences,Volume 10, Issue 1,Pages 69-77.

[12] Nassar, K., & Al-Musawi, Z. (2013). Fuzzy neural network for dynamic load balancing of nodes for ad-hoc network using. *Journal of Basrah Researchers*, 666-678.