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Path Determination for Message Routing in Computer Networks Using Firefly Algorithm

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ABSTRACT

The vast usage of computer networks requires the improvement in network topologies and management techniques so that user may receive high quality of service (QoS). This paper addressed the inefficiency of path determination, reduced network traffic in sending packet and poor bandwidth management. The problem is addressed by introducing the use of meta-heuristic algorithm (Firefly) which may be combined with other optimization techniques for efficient network routing is basically essential. The focus of this study is quantitative analysis and experimental evaluation of firefly algorithm in packet transmission with mesh topology by routing a message from one node or host broadcast to another in ten (10) nodes hypothetical (WANET). Simulation is carried out in MATLAB 7.5 to demonstrate the efficiency of firefly algorithm for routing in computer network. Experimental performance is examined, by measuring the delay time in seconds and compared against packet size for quality of service. The simulation result and analysis shows that firefly algorithm is suitable for path determination and more efficient in implementing open shortest path first (OSPF + firefly) than existing algorithm for OSPF routing alone.

Keywords: OSPF, WANET, Routing, Algorithm, Firefly, Simulation.

1. NTRODUCTION

In computer networks, networked computing devices transfer data and information to one another along network links through data connection. Computer network is an interconnection which allows computers to exchange data and/or information. The connections between nodes are established using cables or wireless media. As newly-starting flow joins the network, it is expected that the flow should grab the available bandwidth of the link as soon as possible (Xiaomeng et al, 2007). As networks become abundant, the quality of service received by user begin to degrade, therefore it become imperatives to focus on the quality of service (QoS) that is being provided to the users of network (Sunita & Zaheeruddin, 2011). As more individual transmit data via computer network, the quality of service received by user begin to degrade, due to this, a research on computer network routing is germane to improvement. Routing plays a significant role for providing a well delivering qualitative service in networks (Anupama et al, 2016). Consequently, routers are free to move randomly and organize themselves arbitrarily, and thus, the network's wireless topology may change rapidly and unpredictable situation could occur (Onifade, Ojesanmi&Oyebisi, 2013).

Experimental study was carried out where congestion, throughput, failure rate, and distance were used as metrics for comparison with open shortest path first (OSPF) conducted in decades back. Recently, Odekunle, Alese and Abiola (2012) proposed the use of neuro fuzzy system (NFS) for message routing in a computer network. The NFS uses bandwidth and delay as input data with decision support system based on cognitive filtering in fuzzifying the routing to select the most effective route/path with maximal bandwidth usage subject to efficient minimal path delay. Recently, Adebare (2015) also proposed the use of Neuro-Fussy Model (NFM) for determining shortest routing path in a computer network. According to previous researches, message routing in a network is a 'compound concept or process' because the network topology may change steadily and accessible state information for routing is inherently indefinite (Odekunle et al, 2012). Current devices are also focusing on wireless local area network (Onifade et al, 2013).

2. RELATED WORKS

A network is the typical set and connection of two or more devices with or without geographical proximity for the purpose of communication among users. Networking is associated with structural specification, technical design, functional parameters and configuration of devices with the installation of communication equipment's for data transmission. Nubunga (2015) affirmed that internet has evolved into a widespread network and inspired the development of a variety of new applications in business and other sphere of human endeavour. Management tools are required for network monitoring and profiling, especially to speed up development and testing (Adeyeye[M], Adeyeye[R]&Gelder, 2013). Nubunga (2015) stated that support of real-time services or multimedia applications in the presence of link failure is the significant issue in nowadays networks. Onifade et al (2013) proposed fuzzy logic model for managing the quality of service in mobile ad hoc networks (MANets); constraints such as limited bandwidth, power instability, mobility, dynamic topology, network scalability and multi-hop routing are detrimental to the quality of service. There is high demand placed on the network by these new applications and services, in terms of speed, bandwidth and accessibility which had strained the resources of existing internet infrastructures (Nubunga, 2015).

2.1 Wireless Adhoc Network

A wireless ad hoc network is a decentralized type of wireless network, the network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity. In addition to the classic routing, ad hoc networks can use flooding for forwarding data (Chai, 2002). The decentralized nature of wireless. ad hoc networks makes them suitable for a variety of applications where central nodes can't be relied on and may improve the scalability of networks compared to wireless managed networks, though theoretical and practical limits to the overall capacity of such networks have been identified (Siva, 2004).

Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural disasters or military conflicts. The presence of dynamic and adaptive routing protocols enables ad hoc networks to be formed quickly. The auto-configuration in WANET makes it to WANETs can either be stand-alone networks or may be connected by a gateway to other wired networks (like the Internet) or other wireless networks. It is to be noted that wireless interfaces do not have a complete view of the network; instead each wireless interface has different unique partial view of the WANET. It may have a particular neighborhood, which afflicts the need of routing and auto configuration algorithms. Also, nodes send and receive packets on the same interface, so duplicate IP messages may occur on WANET routers with several adjacent nodes. Issues in auto-configuration: The chief goal of auto-configuration is to configure globally unique and topologically correct IP addresses. It is achieved using following number of steps to ensure the address configured is unique and not duplicated to avoid ambiguity in transferring packets.

2.2 Routing and Congestion Control

Routing is the process of getting information packets where they need to go. Routing is an astounding complicated task, and there are a number of diverse algorithms used to find the shortest route between two points (Adebare, 2015).Distance between two nodes communicating with each other at a particular time is calculated; being an important factor in transmitting a packet directly which depends on the distance between the nodes (Manshahia, 2015). Ojo et al (2015) opined that designing the appropriate congestion control scheme that will ensure fair allocation of available bandwidth to peers and schedule video frames to peers at a defined control rate is important. Xiaomeng et al (2007) opined that stability is highly required for congestion control algorithm; any algorithm for congestion control must be stable and adaptive with a wide range of scalability parameters on network.

Ojo et al (2015) presented peer to peer congestion detection and avoidance system, to alleviate the impact of peer to peer traffic on traditional internet traffic. Congestion can occur while transferring the data from source to sink, congestion control in WSNs means to improve the performance when demand for the finite transmission capacity exceeds the supply (Manshahia, 2015). Previous research on congestion control iterated the stability criterions for transport protocols (Xiaomeng et al, 2007). Sunita and Zaheeruddin (2011) wireless ad hoc networks are likely to be the centre of future communication. Although it is difficult but providing quality of service guarantee has become essential for operation of wireless networks. Problems encountered in Wireless Mesh Network (WMN) solutions include bandwidth degradation, radio interference and latency (Adeyeye et al, 2013). Osunade (2012) emphasized the need for methodology of monitoring and metric collection that is bandwidth-efficient and scalable with respect to the number of devices in the network. The QoS routing protocols are tasked with the gathering and managing state information and ensuring that it is as accurate and consistent as possible in real time, without too much lag in maintaining its precision; different approaches for more efficient routing message through a computer network is proposed in recent literature (Adebare, 2015).

2.3 Related Works on Network Routing

Anupama et al (2016) integrated Firefly Algorithm (FA) with Artificial Neural Network (ANN) to predict the software cost accurately. Manshahia (2015) proposed a Firefly Based Energy Efficient (FBEE) routing in Wireless Sensor Networks (WSN). Odekunle et al (2012) developed an expert system for message routing in a switched network environment. Osunade (2012) developed a suitable model for packet routing in computer network. Sunita and Zaheeruddin (2011) reviewed and compared the quality of service routing in wireless networks. Xiaomeng et al (2007) designed a congestion control system – Coupling Logistic Transmission Control Protocol (CLTCP) using population ecology model, it is based on bandwidth pre-assignment consisting link and source algorithm for high speed networks) to improve the convergence and stability of congestion control.

3. METHODOLOGY

This research adopt quantitative research by simulating hypothetical wireless ad hoc network (WANET) of ten (10) nodes in mesh topology to demonstrate the efficiency of firefly algorithm for message routing in computer network. The simulation encompassed the above network with Open Shortest Path First (OSPF) and Open Shortest Path First with firefly algorithm (OSPF + firefly algorithm). Experimental performance were examined, by measuring the delay time in seconds and compared against packet size of the routed message unit for quality of service (QoS) in order to determine the suitability of firefly algorithm for implementing open shortest path first (OSPF) as protocol for optimized link state routing. The goal is to determine optimal path for routing, therefore, the delay for every possible route(s) between source and destination represent the cost, the route(s) with minimum cost will be selected for transmitting the message or data packet. Algorithm for minimizing delay time so as to select optimal path for routing by predicting the shortest and/or fastest route are presented in this chapter. Manshahia (2015) defined throughput as the ratio of packet size and the delay time. The flowchart of firefly algorithms is necessary to understand when simulating for the efficiency of firefly in message routing. Below is the figure of a procedural block of firefly algorithms.

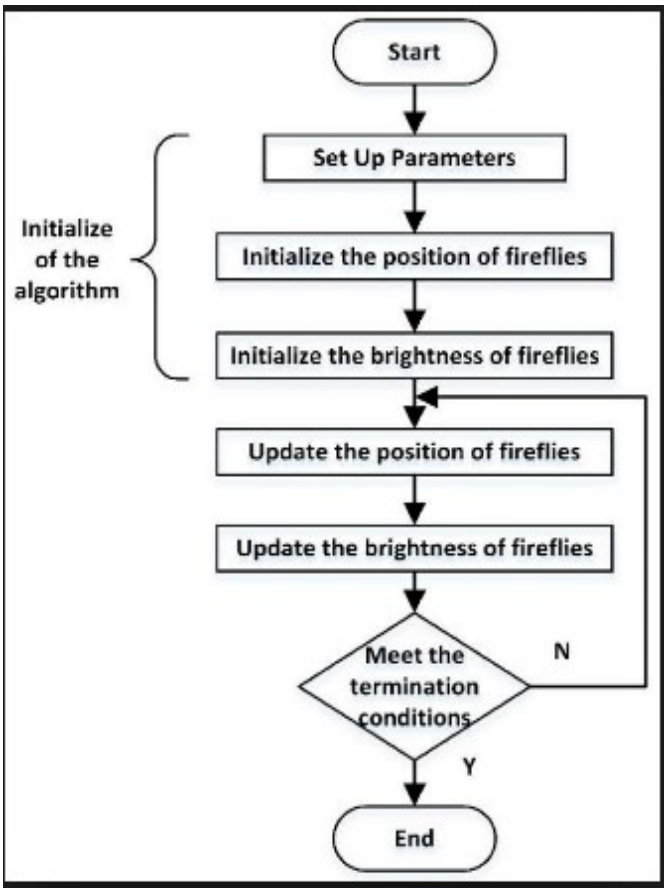


Fig. 1. Procedure Block for Firefly Algorithm (Source Aiming Liu, et al. 2017)

3.1 Simulation Parameters

In firefly algorithm, light intensity and attractiveness are the two important variables. Firefly is attracted toward the other firefly that has brighter flash than itself. The attractiveness is depended with the light intensity. Initial population of fireflies is generated with the objective function, thereby defining the light intensity by absorption coefficient in order to examine the attractiveness of fireflies to one another. For each of the fireflies in the given population, check the light intensity against the next if it is higher; then firefly 2 is brighter than firefly 1, therefore move firefly 2 towards firefly 1 for signal. The data packet (i.e message) to be transmitted from source node, s to destination node, d will from through route i to route j to determine the maximum number of channels or hop count for available routes as delivery paths.

4. RESULT AND DISCUSSION

4.1 Simulation Using Open Shortest Path First (OSPF)

Ten (10) nodes hypothetical network with mesh topology was simulated using convectional OSPF with the specification given below

TABLE 1.0: Specification of Hypothetical Computer Network (WANET) on OSPF

Node (Host)	Path (Link Routes)	Broadcast Cost (b/s)
1 (Source)	2,3	(1-2)=15; (1-3) = 10
2	4,5	(2-4)=8; (2-5)=9
3	4	(3-4)=3
4	5,7	(4-5)=7; (4-7)=6
5	6,7	(5-6)=5; (5-7)=2
6	8	(6-8)=12
7	8	(7-8)=10
8	9,10	(8-9)=6; (8-10)=10
9	10	(9-10)=8
10 (Destination)	Packet Delivery	

MATLAB command codes for simulating the above network is given below:

>>AdHoc_WLAN=sparse([1 1 3 2 2 4 5 4 5 6 7 8 8 9], [2 3 4 4 5 5 6 7 7 8 8 9 10 10], [15 10 3 8 9 7 5 6 2 12 10 6 10 8], 10, 10)

The MATLAB command ***'graphshortestpath'*** is executed to find the shortest path. The syntax for the command and its equivalent outputs are shown below:

Syntax:
>>[minimum_cost,shortest_path]=graphshortestpath(AdHoc_WLAN,1,10)

Output: minimum_cost = 39 , shortest_path = 1 3 4 7 8 10

MATLAB command code to view the above network is given below:

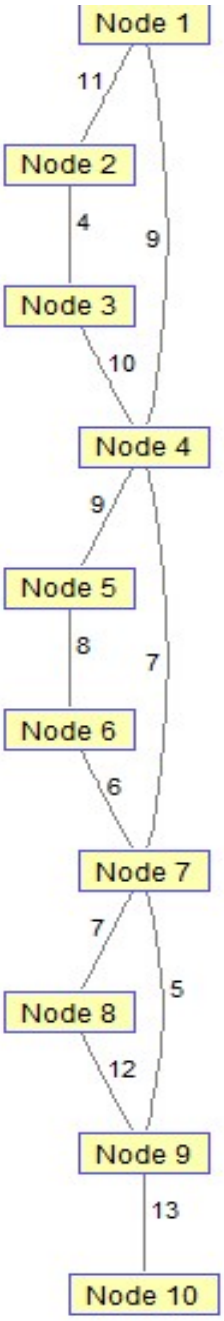
>>view(biograph(AdHoc_WLAN, [], 'ShowArrows', 'off', 'ShowWeights', 'on'))
The output of the above command is shown below:

4.2 Simulation Using Ospf With Firefly Algorithm
Ten (10) nodes hypothetical network with mesh topology was simulated using OSPF with Firefly algorithm based on the specification given in table below:

Table 1.2: Specification of Hypothetical Computer Network (WANET) on OSPF with firefly

Node (Host)	Path (Link Routes)	Broadcast Cost (b/s)
1 (Source)	2,4	(1-2)=11; (1-4) = 9
2	3	(2-3)=10
3	4	(3-4)=9
4	5,7	(4-5)=7; (4-7) = 8
5	6	(5-6)=6
6	7	(6-7)=7
7	8,9	(7-8)=5; (7-9) = 12
8	9	(8-9)=13
9	10	(9-10)=4
10 (Destination)	Packet Delivery	(10-11)=5

MATLAB command code for simulating the above network is given below:
>>AdHoc_WLAN=**sparse**([1 1 2 3 4 4 5 6 7 7 8 9 10], [2 4 3 4 5 7 6 7 8 9 9 10 10], [11 9 4 10 9 7 8 6 7 5 12 13 4], 10, 10)



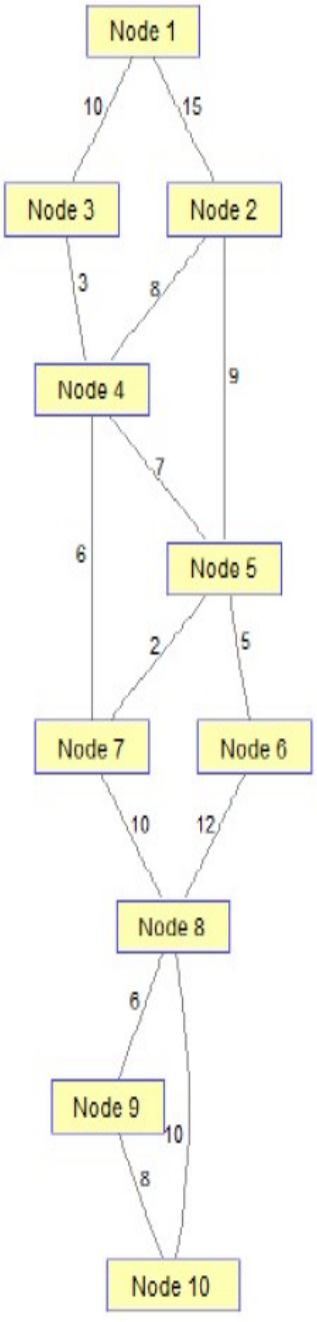


Fig. 2.0 OSPF + FIREFLY **Fig. 3.0 OSPF ALONE**

Results presented in tabular forms below provides a strong argument that MATLAB has a capability for the simulation of computer networks for message routing when appropriate functions are called. Simulation with firefly algorithm for OSPF and OSPF alone confirmed that hypothetical network with 10 nodes has the shortest paths linking nodes 3, 4 and 7 from the source to destination. The results from analysis also confirmed that the minimum cost of routing a message from node 1 (source) to node 10 (destination) is 34, evident from the simulation results by the projected firefly algorithm. This is the suitable mechanism in implementing open shortest path first. According to Gihan and Wahied (2010), a reliable routing algorithm should be able to transfer packets (messages) from source node to destination node with minimum cost and reduced delay time. It has been recommended by Odekunle et al. (2012) that the efficiency of the routing protocol can be optimized by combining it with nature inspired algorithm. OLSR gives minimum network load by maximizing throughput and in terms of delay (Shabbir et al., 2015). Many routing protocols used in WLAN helps define set of protocols that can enhance the bandwidth utilization, minimum energy consumption, higher throughputs, less overhead loss (Nwoko et al., 2014).

Table 1.3: PACKET (KB/MB), OSPF + Firefly and OSPF

S/N	PACKET (KB/MB)	OSPF + Firefly	OSPF
1	150KB	1.50	2.10
2	275KB	3.15	4.20
3	410KB	5.24	6.37
4	560KB	7.46	8.00
5	750KB	9.00	9.85
6	900KB	10.32	11.55
7	2.5MB	12.28	13.62
8	5.7MB	14.65	15.80
9	7.8MB	16.50	17.95
10	9.4MB	18.74	19.63

5. CONCLUSION

The results shown in the preceding simulations confirmed that the performance of OSPF with firefly is comparable to OSPF alone in delay time, and far better in terms of routing efficiency and throughput for varying packet size on network.

From this research, the following contributions have been made to knowledge:

a) Parameters for evaluating the quality of service (QoS) were all examined.
b) Potency of MATLAB in optimization modeling of routing was iterated.
c) Hypothetical network was created and simulated using firefly algorithm.

6. FUTURE DIRECTIONS

The drawback encountered in the research suggested the need for improvement to this dissertation. The future research may focus in the following directions:

a) Live computer network environment to improve this method of routing.
b) The need to increase the network metrics with hop count and congestion.

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