A WEIGHT INFLUENCE OF LOGARITHMIC AND EXPONENTIAL FUNCTIONS ON THE SELECTION OF WIRELESS NETWORKS USING MULTI-CRITERIA DECISION-MAKING METHODS

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ABSTRACT

This research aims to study the influence of logarithmic and exponential functions on the multi-criteria decision-making algorithm that changes linear method to nonlinear method. It is carried out to better understand the multi-criteria decision-making, namely the technique for preference by similarity to ideal solution (TOPSIS) algorithm whereby in which these functions may influence the criteria weights during the selection of the best network. The investigation is applied under different network types to evaluate the most optimum network that leads to better throughput, low latency, minimum BER, and low price per MB. The algorithms are assessed in MATLAB simulation environments. The study also considered the adoption of the Wi-Fi networks standard which is factors such as bandwidth, signal to noise ratio and the channel modulation technique were determined during the decision-making process. The simulation results show that the exponential function had produced approximately similar results to that of linear TOPSIS algorithm because both methods keep the weights to demonstrate positive values. However, logarithmic TOPSIS produced different results as the weights have negative values which lead to a phase shift of 180° during the decision process. Thus, linear TOPSIS was found to have the best results while logarithmic TOPSIS had the worst outcome.

Keywords: *Multi Criteria Decision Making, AHP, TOPSIS*

RESEARCH HIGHLIGHTS

1. To optimize and simulate TOPSIS algorithms used for the best wireless network candidate that depends on the end-user real-time services.
2. To Study the influence of logarithmic and exponential functions on the multi-criteria decision-making algorithm that changes linear method to nonlinear method.
3. To better understand the TOPSIS algorithm in influencing the criteria weights during the selection of the best network.

GRAPHICAL ABSTRACT

We consider three different Wi-Fi networks topology as defined in IEEE 802.11 standards, as shown in Fig. 1.

Fig. 1. Network Topology Simulation

Research Objectives

This paper aims to assess and enhance TOPSIS algorithms (1) (2) that is utilized by the best wireless network candidate based on the real-time services required by the end-user. Additionally, the effects of logarithmic and exponential functions on the multi-criteria decision-making algorithm will be studied on, especially on its ability to change the linear method to nonlinear method. This will provide a clearer understanding on how the multi-criteria decision-making algorithm affects the factoring weights during the process of selecting the ideal network. This study utilizes three unique algorithms that is based on throughput, latency, BER, and cost per Mb – as these factors have an effect on the various networks throughout the selection process.

Methodology

The wireless network was dimensioned by defining some technology and topology related parameters such as throughput, latency, BER, and price per Mb as in selection and decision process (3). Then, the weight in each criterion was calculated by the analytic hierarchy process (AHP) algorithm that has ability to evaluate the weight of different parameters of a candidate network. In addition, in order to determine the relative importance of each

objective and sub-objective, a pairwise comparison technique is used. The comparisons are performed between pairs of elements within each branch of each level of the hierarchy to determine the relative worth of one element as compared with another in relation to the element directly (4) (5) (6). Additionally, the weights affect the grading values of linear-TOPSIS, logarithmic and exponential algorithms quality. The change in criteria and attributes based on the TOPSIS algorithm is assessed with a linear, logarithmic, and exponential behavior by considering various parameters. Therefore, with regards to the parameters, we use three different Wi-Fi networks defined by (IEEE) 802.11 standards. In addition, the SNR values, bandwidth, and M-QAM modulation techniques for all the Wi-Fi networks were varied.

Results

Table 1 summarizes the parameters considered in the simulation for the three chosen Wi-Fi networks. In the Linear-TOPSIS, Fig. 2 (a) illustrates that the algorithm is inclined to pick the ideal candidate network based on the high throughput value and latency even with the high price of data rate flow as in Table 1. The method then selects a substitute with the most similarity to the optimum solution. TOPSIS considers each attribute either takes a gradual increasing or decreasing network. The graph in Fig. 2 (c) illustrates the results of selection networks with exponential-TOPSIS algorithm. The weights were changed and it was found that the exponential-TOPSIS algorithm produced same results when compared with the linear-TOPSIS. In other words, the behaviour of exponential function resulting in the score network decisions as that of linear-TOPSIS. Fig. 2 (b) presents the results of the three networks with logarithmic-TOPSIS algorithm. The change of weight resulted in negative values before normalizing. However, after normalizing in the TOPSIS method, the algorithm choose the poorest network as the best candidate network. This is might be due to the behaviour of the logarithmic function results, which made phase shift of 180° or opposite decision compared to both Linear-TOPSIS and exponential-TOPSIS.

Table 1. The Basic Parameters for TOPSIS Algorithm

Network parameters	IEEE 802.11 g	IEEE 802.11 n	IEEE 802.11 ac
SNR	40	30	20
BW	20	40	80
Channel/modulation	256-QAM	64-QAM	16-QAM
Throughput (MB)	259	385	506
Latency (ms)	0.0747	0.0374	0.0188
Price per MB (\$)	12.95	19.27	25.31
BER (10^{-3})	0.0015	0.0022	0.0006
Distance	50mm		
Price per Mb [\$]	0.05\$		
The number of packets.	260		
Packet per size.	1000		
Length of packet	1492

Fig. 2. The Weightage Versus Network Types for Linear-TOPSIS (a), Logarithmic-TOPSIS (b) and Exponential-TOPSIS (c).

Findings

With a thorough coverage of theoretic ideas and formulas, and the idea of combining these methods, we have identified the ideal solutions to network selection complications. Based on the obtained results, we found that the linear and exponential TOPSIS algorithms have the same result and will constantly choose the ideal candidate network compared to logarithmic TOPSIS algorithm.

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