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ANALYSIS OF ENERGY CONSUMPTION OF SELECTED CLUSTER TECHNIQUE

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ABSTRACT

The study is about wireless sensor networks which plays important role in modern human life. The wireless sensor networks pose crucial problem of energy consumption which is investigated in this study. Three types of cluster technique including K-means, Fuzzy, and SOM were analyzed in the present study based on 50 nodes and 100 nodes network. The results were compared based on various velocity m/s and percentage of energy decay in the network. The results show that among the three cluster techniques, the Fuzzy method turned out to be the most energy efficient method.
Keywords: Energy Consumption, Cluster, K-Means, Fuzzy.

INTRODUCTION

For monitoring certain environmental or physical conditions such as pressure or temperature, wireless sensor network is frequently utilized in modern industrial age. The wireless sensor network function by cooperatively passing the data through the network to a centralized location (Sasikumar & Khara, 2012). No one can deny the importance of modern-day wireless sensor network as they are used in variety of settings such as car parks, automatic doors, construction, industrial settings, security organizations and more. Examples includes a farmer monitoring the temperature of his field, and surveillance of prisons using the wireless sensor networks.

The purpose of developing wireless sensor networks is to detect particular event or estimate physical parameters such as in civil applications such as medical or agriculture, and in military settings such as target tracking and fire hazard identification (Prabhu & Sophia, 2011).

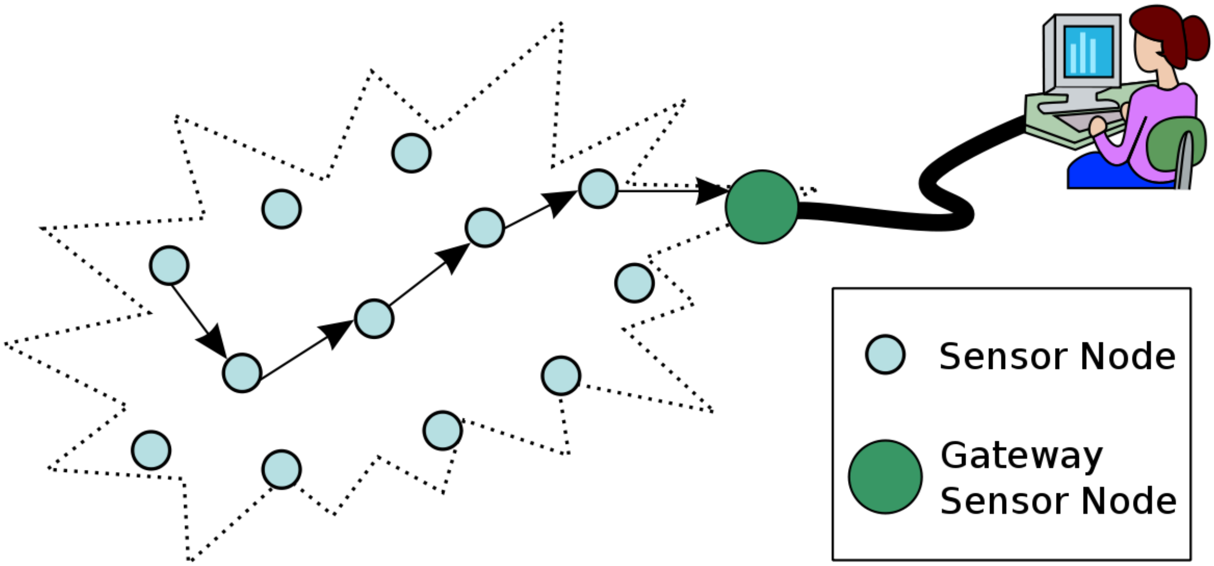

Figure 1: Wireless Sensor Network

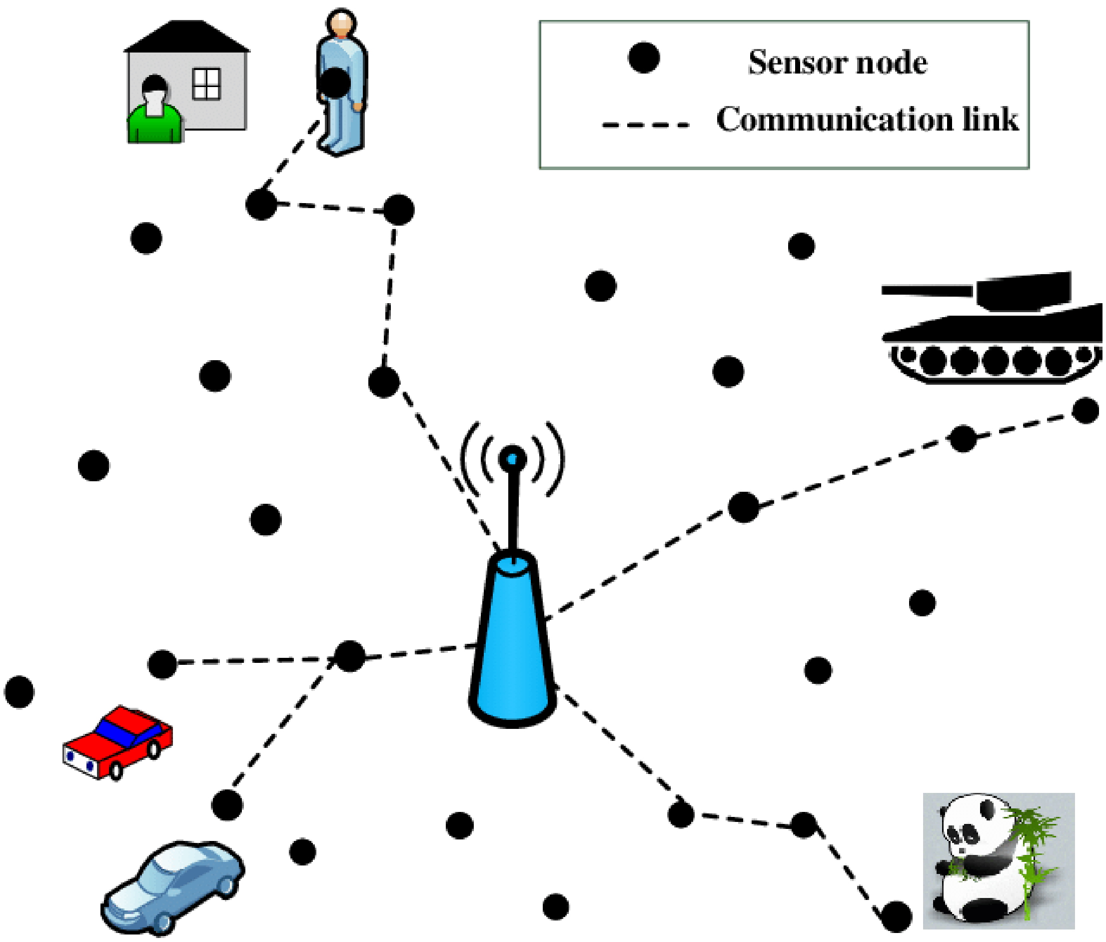

Figure 2: Wireless Sensor Network Uses

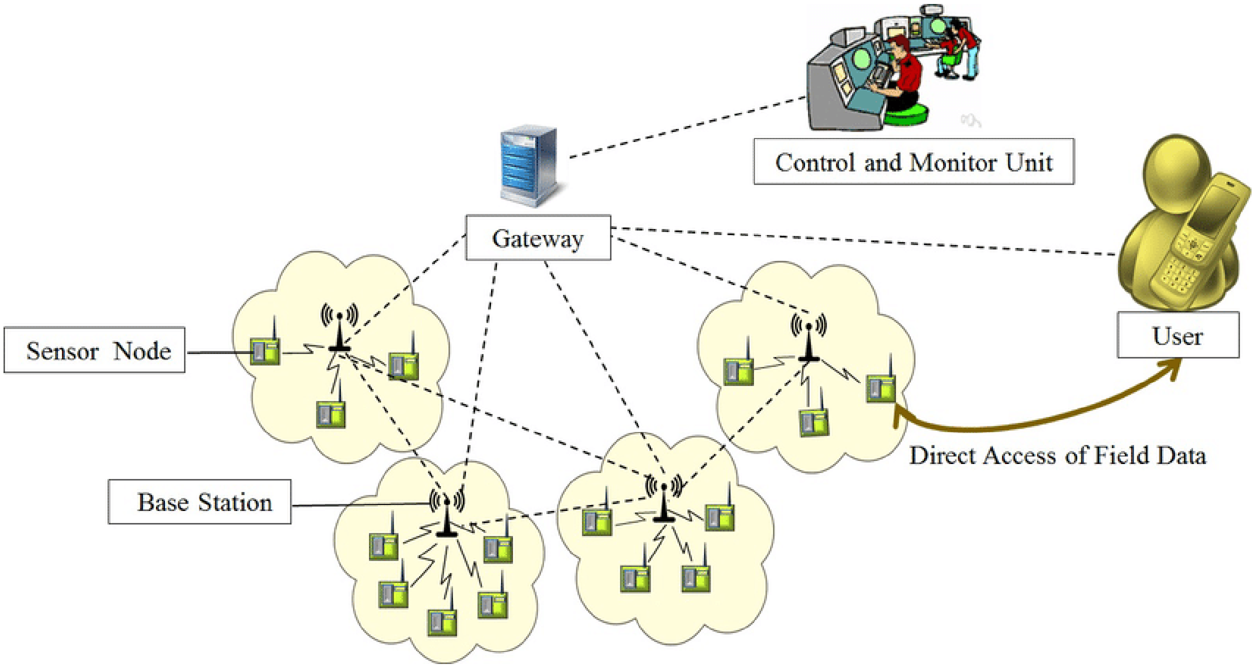

Figure 3: Wireless Sensor Network Anatomy

There are variety of wireless sensor networks which varies based on their use. Thus, there are different categorization schemes for different types of wireless sensor networks. Different wireless sensor networks also vary in terms of how they consume resources such as energy. Mostly, they collect data and send it to sink or multiple sink nodes (Lindh & Orhan, 2009). For sink nodes, mobility is not an issue as most sink nodes are stationary. However, in some cases, the sinks are expected to be mobile when they are integrated with other mobile devices such as cell phones. In such situation, optimization of communication cost and overhead in wireless sensor networks handling is a main concern and efforts are made to develop an optimized solution given the network requirements.

Previously, the wireless sensor networks are characterized as low cost, energy constrained, small, and autonomous nodes which are distributing dove ran area for sensing or monitoring. Mutli-hop routing is mostly used for communicating or relaying of data (Kori & Baghel, 2013). Most wireless sensor networks architecture consist of source nodes and sink. The source node is generating data based on some suitable sensors such as radiation, humidity or temperature. The sink nodes are used for collecting the data gathered by source nodes. Additionally, there can be intermediate nodes which provide support in data transmission from sources to sink. The way a network is designed can significantly influence its robustness and capacity. One network design from the other also influence its processing and data routing capacity. For instance, a highly dense network of wireless sensor requires to pick the topology carefully based on its requirements. A common sensor network topology is provided below.

Clustering

For reduction of energy consumption, a clustering and node redundancy approach is analyzed extensively. Based on clustering approach, cluster are made based on division of sensor nodes (Thangavelu & Pathak, 2014).

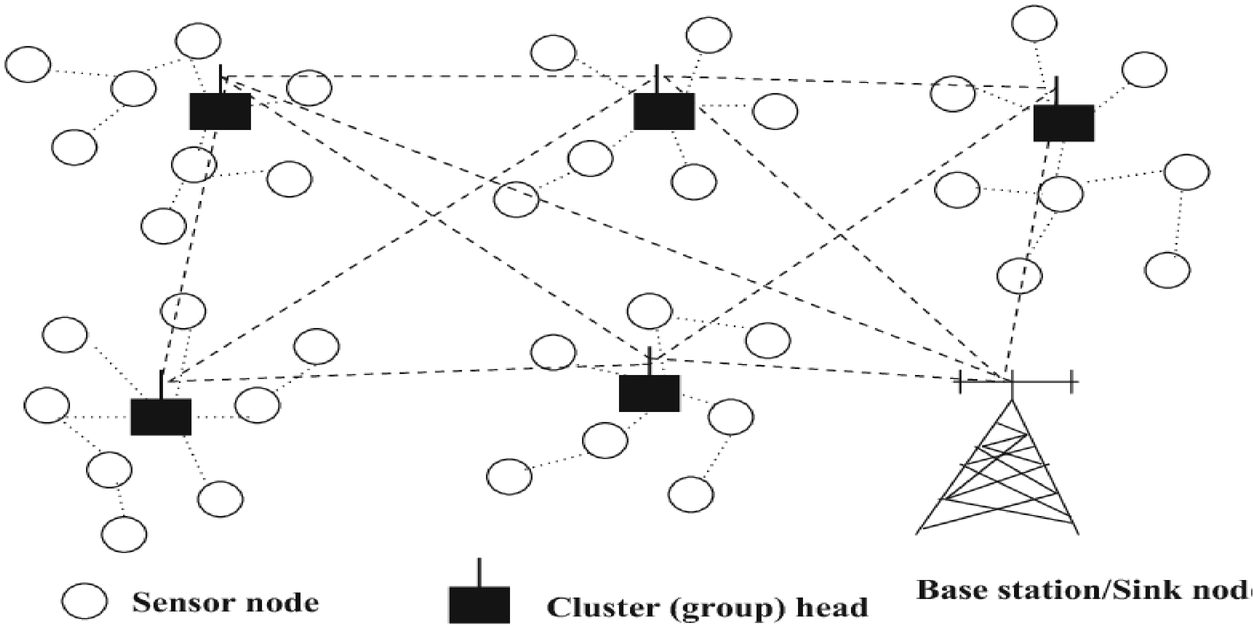

Figure 4: Clustering based Network

K-Means Based Wireless Sensor Network

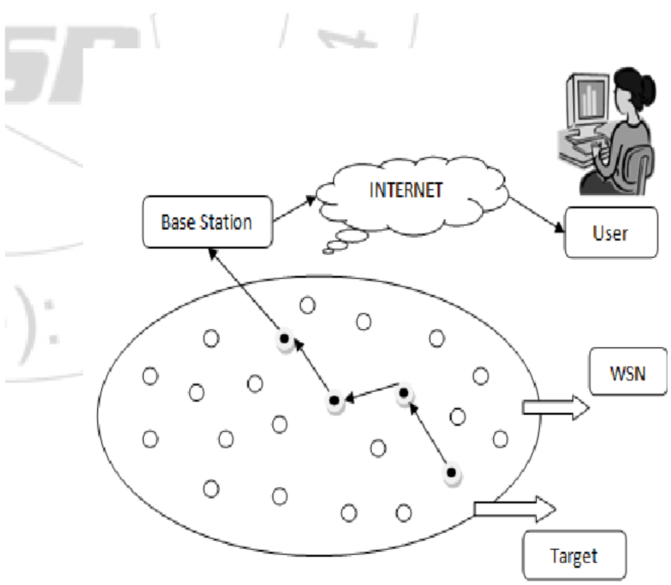

Figure 5: K-Means based Network

Fuzzy Method Wireless Network

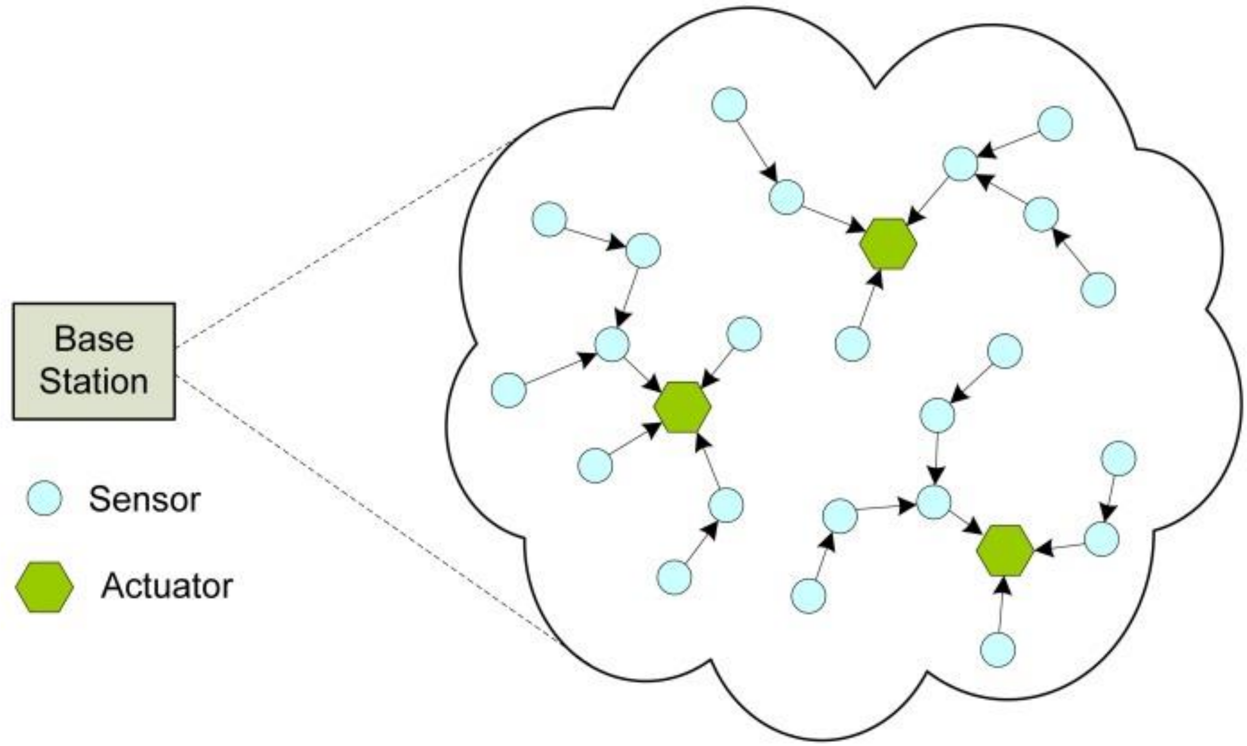

Figure 6: Fuzzy Method Wireless Network

SOM Wireless Sensor Network

Cluster head is the title of leader in each cluster which sends collected data on aggregate basis to base station (Enzinger, 2012). The benefit of clustering is that it allows reduction of duplication data and only submitting important data. It also limits data transmission and thus reduce the resources requirements. An efficient cluster system can make network stable and enhance its lifetime by reduction in network traffic.

Energy Consumption

Energy is consumed in all the phases of protocol in the starting for the election of the cluster heads. Data transmission starts follows after the election phase which all sensor nodes submit data to their cluster heads and at this point, energy is consumed because of receiving and sending the data (Orhan & Lindh, 2010). Comparison of HCR and LEACH shows that less energy is consumed in situation where network is based on more cluster heads compare to less cluster heads-based network.

SIMULATION RESULTS

We used 50 nodes and 100 nodes based on various clustering techniques such as Fuzzy clustering, SOM, and K-Means for comparing the energy consumption of these various techniques. The result is based on wireless sensor network against velocity in m/s for percentage of decay rate of energy. For evaluation of cluster characteristic the metrics included the number of single-node clusters, cluster size variance, maximum size of clusters, and average cluster size. The results are provided in the following table.

Table 1: Simulation Results

S. No	Parameter	Value
1	Clustering Technique	K-Means, Fuzzy, SOM
2	Update time	3 Sec
3	Sink velocity	60-320 m/s
4	Update distance	40 m
5	Network length	1080 * 1080 m^2
6	No. of Nodes	50 and 100
7	No. of Clusters	10

It can be seen that average cluster size is influenced by network density and transmission range of the sensor nodes. The ideal network should not be too small as is not cost effective. On the other hand, if it is too large, it will be unmanageable causing increased transmission delays and message collision. The simulation results are based on 50 nodes and 100 nodes separately.

Table 2: Comparison of Energy Consumption for 50 Nodes of Three Clustering Technique

Velocity m/s	% Decay Rate of Energy		
	K Means	Fussy	SOM
50	1.1	1.2	1.9
100	2.4	2.3	2.8
150	3.4	3.1	3.9
200	4.7	4.2	4.8
250	5.8	4.9	5.9
300	6.9	5.3	6.6

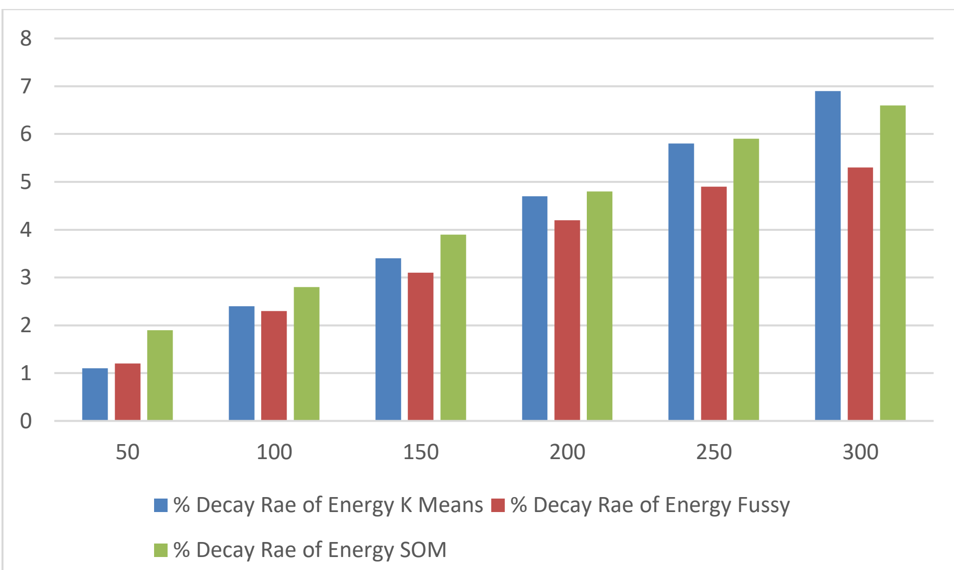

Figure 7: Comparison of Energy consumption for 50 nodes of three clustering technique

The comparison of energy consumption for 50 nodes-based cluster technique are provided in the table above. The results states that for different velocity m/s, the decay rate of energy is increasing. For example, for K means based cluster network, at 50 it is 1.1 and increased to 3.9 for 300 velocity m/s. For Fussy, at 50 velocity m/s, it is 1.2 which increased to 5.3 at 300 velocity m/s. For SOM, at 50 velocity m/s, it is 1.9 which increased to 6.6 at 300. Overall, the comparison shows that among the three networks, the Fussy cluster technique is the most suitable one based on less decay rate of energy.

Table 3: Comparison of Energy Consumption for 100 Nodes of Three Clustering Technique

Velocity m/s	% Decay Rate of Energy		
	K Means	Fussy	SOM
50	1.3	1.4	2.2
100	2.6	2.6	3.2
150	3.5	3.3	4.3
200	4.8	4.5	5.1
250	5.9	5.3	6.2
300	7.1	5.8	7.4

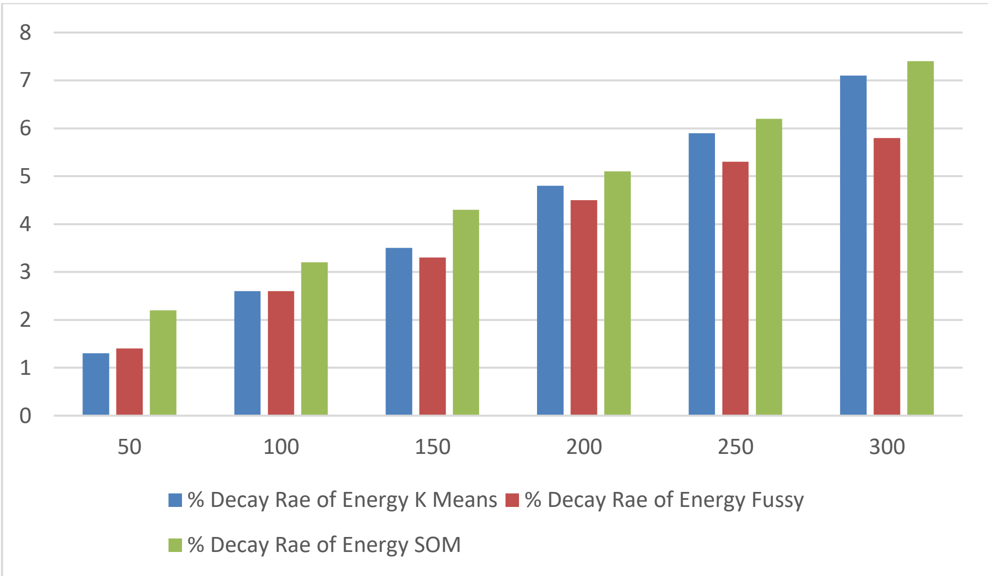

Figure 8: Comparison of Energy consumption for 100 nodes of three clustering technique

The comparison of energy consumption for 100 nodes of three cluster techniques are provided. The results show that at 50 velocity m/s, the K mean decay rate of energy is 1.3 which increased to 7.1 by 300 velocity m/s. For fussy technique, at 50 velocity m/s, the energy decay rate is 1.4 which increased to 5.8 at 300 velocity m/s. For SOM, at 50 velocity m/s, the energy decay rate is 2.2 which increased to 7.4 at 300 velocity m/s. Overall, these results shows that at 50 nodes and 100 nodes comparison, the fussy technique turned out to be the most suitable one since it has less decay rate of energy at various velocity m/s.

CONCLUSION

The objective of the study was to make the comparison between wireless sensor networks of three types including K-means, Fuzzy, and SOM. The experiment was designed based on 50 nodes and 100 nodes-based networks. The results show that among the three-cluster technique, the Fuzzy technique has better qualities in terms of less percentage of energy decay compare to the other two methods. Hence, our study makes recommendation for making use of the Fuzzy method.

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