

## ENERGY EFFICIENT SENSED DATA CONVEYANCE FOR SENSOR NETWORK UTILIZING HYBRID ALGORITHMS

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**Abstract:** The wireless sensor networks incorporated with multitude of distributed autonomous sensors with the potency of monitoring any changes that is physical or environmental, faces few challenges due to its distributed nature and the limited battery availability. The challenges incurred result with delay in the transmission, dynamic topology changes, and the link failures due to the reduced life span of the sensors. The researchers claim that the reduce in the life span of the sensor are the result of energy usage in the transmission leading to an enormous battery power consumption for a single conveyance. So the paper proposes an energy efficient conveyance for the information that are sensed utilizing the hybrid algorithms that include the K-means for the purpose of clustering, Genetic algorithm for the purpose of cluster head selection and the Ant colony optimization for determining the shortest path between the member to the cluster head and the cluster head to the base station. The performance evaluation of the proposed process using the network simulator-2 serves as an evidence for the improved capabilities of the same in terms of the throughput, packet delivery ratio (PDR), energy efficiency and the network life time.

**Keywords:** Wireless Sensor Networks, Challenges, Throughput, PDR, Energy Efficiency, Network Life-Time, Ant Colony Optimization, K-means Clustering and Genetic Algorithm.

### 1. INTRODUCTION

The wireless sensor are tiny elements comprised of a sensor that is used to sense the variations in the physical or the environmental conditions along with the components that required for the processing, communicating the sensed information and the battery to provide the power for the conveying of the information's. The wireless sensor networks incorporated with a multitudes of autonomous sensor that are distributed is designated to sense information's from various sources in real time, so the WSN's could also be described as the dedicated sensor that could monitor even the slight changes in the tangible conditions around and primarily employed in the monitoring of the environmental changes, health conditions etc. These sensors unite together and frame an infrastructure less network that is distributed in nature. These networks framed for a particular purpose using the nearby available and the volunteering sensors to communicate the information gathered to the designated place using the intermediate

sensors as the relay points. Though the sensor network that communicate using the radio waves come up with many potentials such as sensing even minute changes, capable of sensing even areas that are beyond human reach, occupying less space with the capability of the reframing (self-healing), the network incurs challenges due to the limited battery power availability causing poor link stability and the distributed nature resulting sudden changes in the topology. In this the energy usage seems to be major issue to be tackled, as it reduces the life time of the network resulting in the link failures and the improper transmission. The fig.1 shows he components of the sensor node.

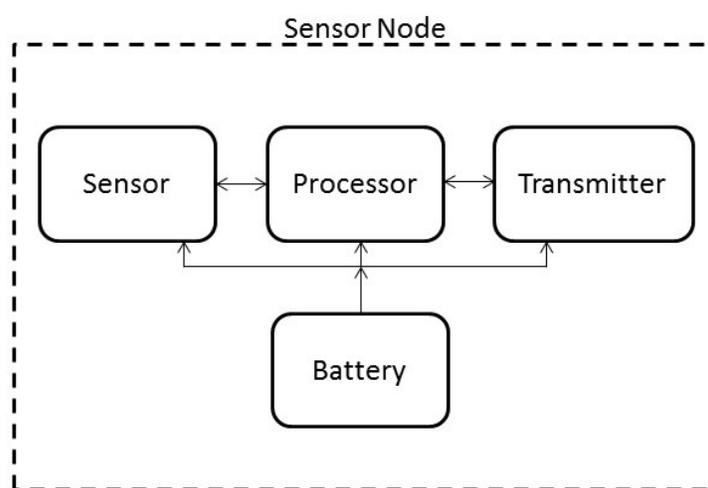


Fig .1 Components in the Sensor Node

Multitudes of researches have been done in the arena of the network that is comprised of the sensing elements due to their potency of gathering information's and the challenges incurred in them [8]. The inbuilt potencies of the wireless sensor networks have been the origin point for the many advances such as the fourth generation industrial revolution [9]. The failures in the wireless sensor network sensed data transmission due to the energy usage is an primary issue that has to be handled.

So the paper proffers an energy efficient conveyance for the information that are sensed utilizing the hybrid algorithms that include the K-means for the purpose of clustering, Genetic algorithm for the purpose of cluster head selection and the Ant colony optimization for determining the shortest path between the member to the cluster head and the cluster head to the base station.

The paper is arranged with the section 2 presenting the related works, section 3 the proposed work for the clustering, the cluster head selection and the shortest path determination using the ant colony optimization. Section 4 the result evaluation and section 5 the conclusion.

## 2. RELATED WORKS

Shivaraman et al [1] the author proposes a reactive hybrid algorithm that is energy efficient to extend the life span of the network. The author utilizes the PSO and the ACO algorithm to provide an enhanced data accumulation and the transmission.

Saini et al [2] the author proposes the virtual grid based dynamic routes adjustment to improve the network performance. The virtual grid based dynamic routes adjustment is based on the genetic algorithm to improve the challenges incurred by the wireless sensor networks in terms of network life span.

Sarkar et al [3] the author proposes the delay diminished routing by using the perfect cluster head selection, with certain criteria to reduce the energy consumption and increase the speed in the process. So the author utilizes the firefly algorithm along with the cyclic randomization to select a perfect cluster head.

Din, et al [4] the author in the aim of overcoming the challenges in the software defined wireless sensor networks, utilizes a multilayer architecture for the selection of the cluster head, rotation, to prevent the energy consumption in the wireless sensor networks in return increasing the life of the network.

Dorigo et al [5] the author presents the survey of the ant colony optimization algorithm along with the discussions of the relation between the ACO and the other approximation methods and elaborates the ACO as the perfect optimization for the combinatorial optimization problem.

Reddy, D. L. et al [6] the authors in order reduce the energy consumption in the network and improve the life of the network, proposes a method to compare the residual energy of the cluster head with the average energy of the network to select the fittest one as the head of the cluster to reduce the energy usage and improve the network life.

Sharma et al [7] the author present the review of the existing cluster head selection methodologies to overcome the challenge's in the wireless sensor network. The paper suggests that the cluster head selection based routing would be energy efficient as well as helpful in prolonging the life of the network.

Reddy et al [8] the paper categorizes the different algorithm for the cluster head selection on the grounds of the stability, network lifetime, throughput, delay, energy consumption etc. to elaborates its efficiency in the preserving the life of the network reducing the power consumption.

Faheem et al [9] the author to minimize the delay incurred in the end-to-end communication and enhance the delivery ratio utilizes the bird matching method for optimizing the energy usage with the improved reliability and minimization of the excessive packet transmission.

Capó, et al [10] the author utilizes the k means algorithm in framing the clusters in order to compute and analyze the enormous amount of data that are been produced in the day to day today lives, the author describes the k means clustering to be efficient than the popular approaches such as the K means ++ and the minibatch k means.

Dorigo et al [11] the author introduces the metaheuristic algorithm that is based on the population to predict solutions for the various "combinatorial optimization problems". The author utilizes the ant foraging behavior to determine the solutions to the problem.

Dorigo et al [12] the author presents the improvements and the applications of the ant colony optimization metaheuristic algorithm as a review to evince its capabilities in addressing the combinatorial problems.

### **3. PROPOSED WORK**

The wireless sensor networks comprising of many sensor nodes in the distributed manner is affected by the link failures due to reduced life span of the nodes caused by the high utilization of the energy. Consider the wireless sensor network incorporated with many sensors in it given as  $W = \{w_1, w_2, \dots, w_n\}$ , allotted in the transmission of the information sensed is liable of incurring failure due to the low availability of the battery power. So the proposed method overcomes the problem of excess energy usage by framing the cluster that is opted as an efficient energy management technique[6] for transmission of the information's to the destination is done by using the k-

means[10], the cluster head selection is achieved by applying the genetic algorithm[2] to enumerate the fittest node as the head of the cluster and further as a next stride to reduce the energy usage the delay-diminished routing is done enumerating the shortest path using the ant colony optimization[11][12] that is based on the foraging behavior of the ants. The flow chart below in the fig.1 explains the strides in the proposed method for achieving an energy efficient cluster head ( $C_H$ ) selection and routing.

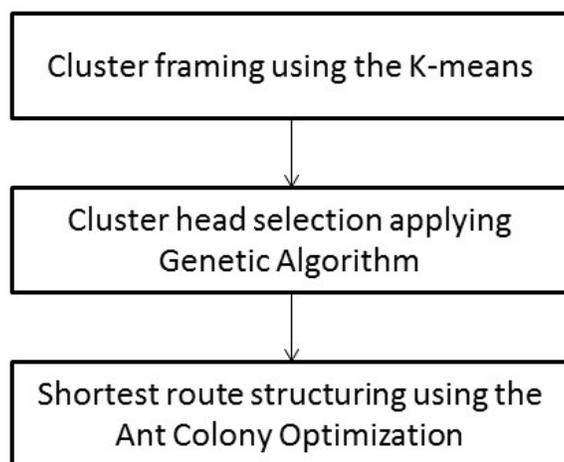


Fig.2 Flow of the Proposed Process

### 3.1. CLUSTERING AND THE CLUSTER HEAD SELECTION

The sensor nodes are framed into cluster by gathering together the nodes with the similar qualities; such that the nodes in the one cluster does not resemble the other, this done by gathering the information of distance between the nodes employing the k-means algorithm. The k-means clustering initially starts with the partitioning of the 'n' sensor nodes present into 'k' clusters, then randomly fixes a center point and determines the distance between the each sensor node and the center fixed, gathers the sensor nodes with the lesser distance to the center point into a group and once again enumerates the center point ( $C_p$ ) applying the formula in the equation (1)

$$C_p = \left( \frac{1}{w_i} \right) \sum_{y=1}^{w_i} x_i \quad (1)$$

Once again enumerates the distance between the new  $C_p$  and the data points and gathering the data points available based on the new  $C_p$  and repeat the steps of the gathering until there remains no sensor node left out without assigned to the clusters.

Once the cluster is framed the information's of the nodes based on their residual energy ( $resi_{energy}$ ) availability, and the distance between the all nodes ( $Dist_{n-n}$ ) are gathered from the each node and enumerated applying the GA to find out the sensor node with the  $\max(resi_{energy})$  and  $\min(Dist_{n-n})$  as the fittest one to be elected as the cluster head, this is repeated for all the clusters. The genetic algorithm utilizing the natural process of selection, mutation and the crossover enumerates nodes to find out the fittest  $C_H$  that is placed at a minimum distance from all the nodes having maximum residual energy availability in it. The flow chart below in the fig.3 explains the cluster head selection process applying the k-means clustering and the genetic algorithm.

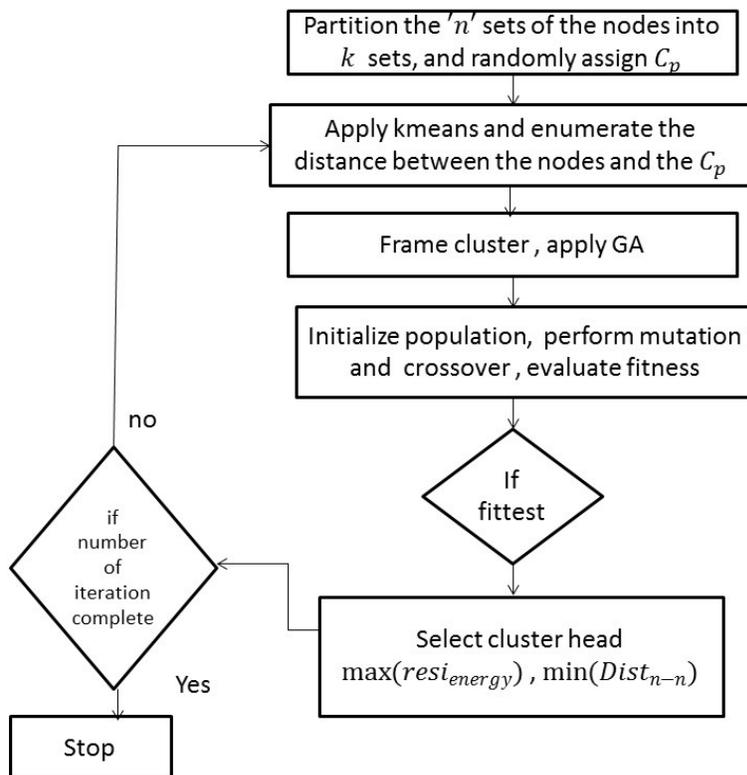


Fig3 K-means –GA for selecting the Cluster Head

### 3.2. SHORTEST PATH FOR CONVEYANCE USING THE ANT COLONY OPTIMIZATION

To determine the shortest path for the conveyance of the sensed data, the sink node sends a greeting message to all the cluster head available, and the cluster head broadcasts them to the available nodes in the cluster, until the source is reached the nodes reply the greeting with the acknowledgement as well as the information of the distance between node and the cluster head ( $dist_{n-ch}$ ) as well as the cluster head replies back to the base station with the an acknowledgement along with the details of its distance to the base station ( $dist_{ch-bs}$ ) along with the residual energy availability, the information of the energy availability and the distance are gathered in the information table and utilized when required to transmit the information this updation is periodically done to note down the distance between the  $C_H$  to the base station, applying the ant colony optimization the proposed method computes the shortest path from the source to the  $C_H$  and the  $C_H$  to the base station. From the possible number of the shortest path available from the source to the destination, the ant colony optimization helps in deciding the shortest path enriched with the nodes containing  $\max(resi_{energy})$  and the  $\min dist$  to the base station, Thus reducing the delay in the conveyance path and the energy usage during transmission. The fig.4 the flow chart below gives the shortest path enumeration for the sensed data conveyance using the ant colony optimization.

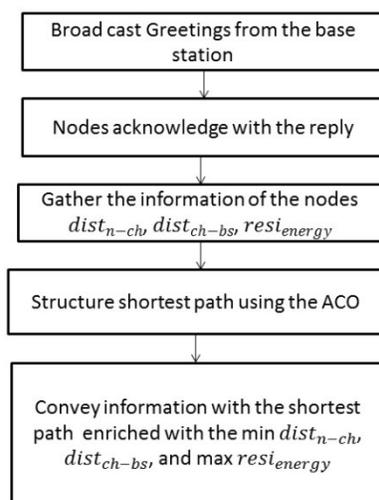


Fig.4 Shortest Conveyance Path

In the optimization based on the ant colony optimization, every individual is described as the artificial agent that stochastically and incrementally constructs solutions to a problem. In every step the solutions is defined and accumulated. The solution acquired is used by the other ants or the artificial agents to find the optimal solution [11].

#### 4. RESULTS

The Kmeans-GA-ACO is evaluated using the network simulator-2 for varying number of nodes ranging from the 100 to 500, for a simulation time of 100 seconds with the, initial energy of 100 joules, and the packet size of 1024bytes. The Kmeans-GA-ACO is evaluated along with the VGBDR (virtual grid based dynamic routes adjustment) and the FACR (firefly algorithm along with the cyclic randomization) and the results are compared in three terms of the delay, energy efficiency and the packet delivery ratio.

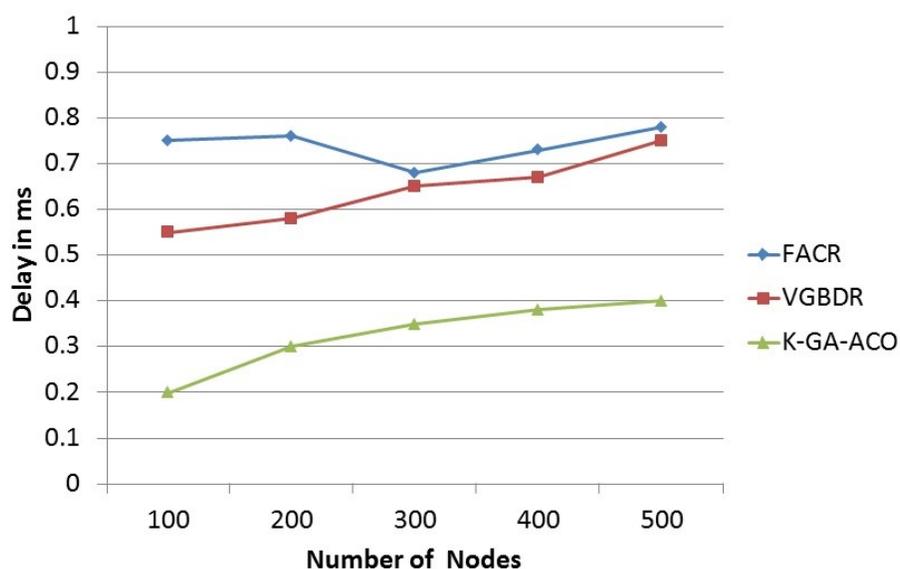


Fig. 5 Delay in conveyance

The fig .5 shows the delay incurred in the conveyance applying the Kmeans-GA-ACO, the results of the proposed are compared with the VGBDR and the FACR. The comparison result show that the proposed method has a diminished delay due to the enumeration of the shortest path compared to the other methods virtual grid based dynamic routes adjustment and the firefly algorithm along with the cyclic randomization.

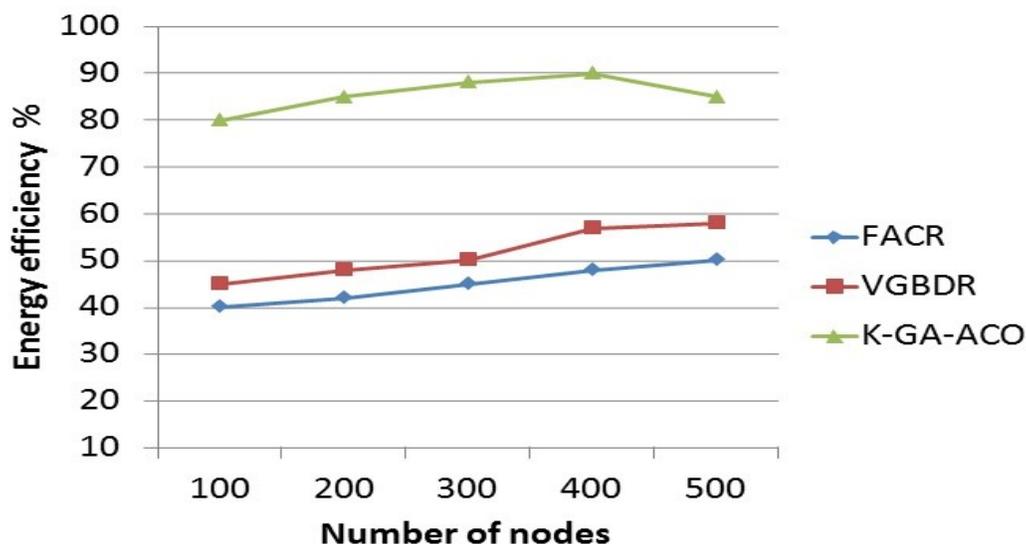


Fig .6 Energy Efficiency

Fig 6. Shows the energy consumption in the conveyance applying the Kmeans-GA-ACO, the results of the proposed are compared with the VGBDR and the FACR. The comparison result show that the proposed method has 50% reduced energy consumption due to the enumeration of the shortest path compared to the other methods virtual grid based dynamic routes adjustment and the firefly algorithm along with the cyclic randomization.

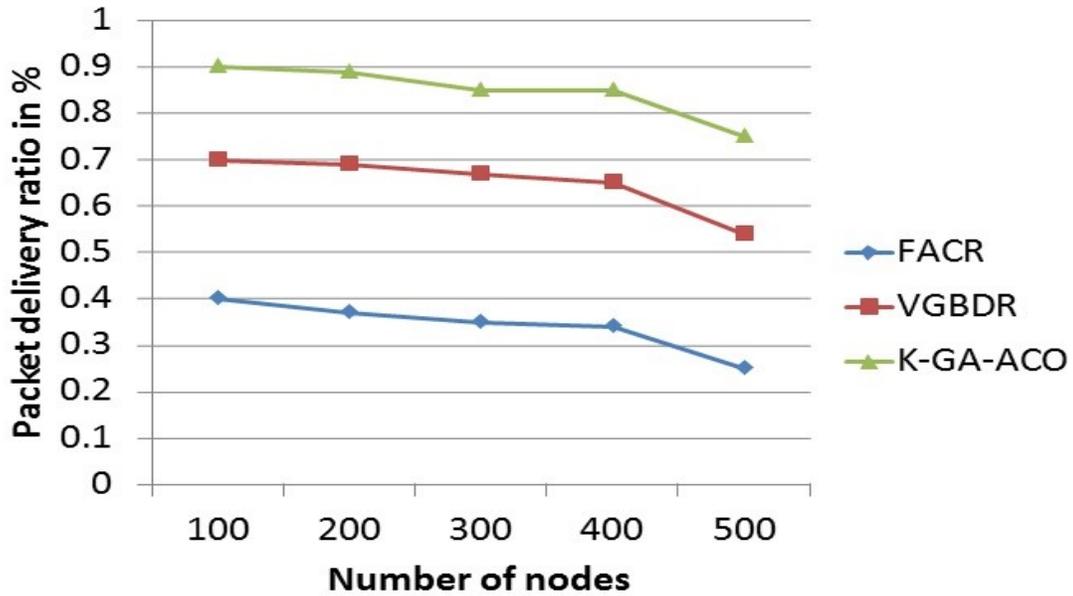


Fig .7 Packet Delivery Ratio

The fig.7 presents the PDR of the proposed method and its comparison with the other methods VGBDR and the FACR. The results acquired shows that the Kmeans-GA-ACO has an improved PDR than the virtual grid based dynamic routes adjustment and the firefly algorithm along with the cyclic randomization. The improved PDR shows the enhanced throughput achieved by the Kmeans-GA-ACO. The table.1 below shows the comparison of the performance metrics of the Kmeans-GA-ACO along with the VGBDR and the FACR

Number of nodes	FACR			VGBDR			K-GA-ACO		
	Delay%	Energy efficiency %	PDR%	Delay%	Energy efficiency %	PDR%	Delay%	Energy efficiency %	PDR%
100	75	40	40	54	54	70	20	80	90
200	78	42	39	59	55	69	30	85	89
300	80	44	38	60	56	65	35	86	85
400	84	45	35	65	57	62	38	88	84
500	83	50	25	70	58	60	40	90	75

Table.1 Comparison of Performance Metrics

## 5. CONCLUSION

The issues in the wireless sensor network that are related to the life-time of the network are addressed in the paper by utilizing the hybridized algorithms. The hybrid algorithms that include the K-means for the purpose of clustering, Genetic algorithm for the purpose of cluster head selection and the Ant colony optimization for determining the shortest path between the member to the cluster head and the cluster head to the base station by gathering the information's of the sensor nodes based on its residual energy, its distance from the base station and the distance from its relaying nodes and the cluster head. This is done to enumerate the short distance between the nodes to the cluster head and the cluster head to the base station thereby reducing the time taken for transmission in return reducing the energy consumption and extending the life-time of the network. Further the performance analysis of the proposed method shows the improved network life span and the throughput achieved for the network using the hybrid K-Means-GA-ACO algorithm. The trust evaluation of the nodes to have a secure communication is continued as the future work.

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