Mobile agent based energy-efficient structured clustering algorithm for WSN

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Abstract*—:** ***Wireless Sensor networks are densely and largely deployed in a variety of environments to sense real-world events. In this paper, we introduced a Mobile agent based energy efficient structured clustering algorithm (MAEESCA) for the sense of environmental factors to support long lifetime, energy-efficient operation. The simulation outcome illustrates that the proposed algorithm is improved at end-to-end delay, energy consumption with extending network performance compared to conventional routing algorithm. And the simulations are conducted for three different networks like SEECH, EESCA and MAEESCA.

Index Terms— MAEESCA, Energy efficient, Clustering, wireless sensor networks

I. INTRODUCTION

WSNs have recently inherit prominence as a result of which they hold potential to revolutionize several segments of our economical life, environmental observance, health care applications, infrastructure protection, context-aware computing, and battlefield awareness. Nowadays, the development of sensor technologies allows the transmission of measured data through wireless communication to the area of interest. The measured values are obtained as electrical signals and transmitted over long distances in the air using wireless technologies. The ultimate goal of such WSNs is often to deliver the sensing data from sensor nodes to sink node and then conduct further analysis at the sink node[7]. Network life time and energy efficiency are major challenges in the field of mobile wireless sensor networks. Solution for offering energy efficiency to the networks is Clustering. In clustered network, nodes are organized in the form of groups and grouping is done on the basis of common properties of sensor nodes. Each group or cluster consists of fixed or varying number of sensor nodes depending upon the mobility behavior of sensor nodes. Communication among the clusters takes place through a gateway. Each cluster has its own cluster head (CH) which is elected on the basis of any of the desired criteria. Various researchers have offered numerous algorithms for cluster head election. CH has assigned the responsibility of establishing communication among the sensor nodes within the cluster through collection and aggregation of the data. Aggregation and filtration of data reduces the chances of data loss, thereby aggregating data to small fixed size. The nodes thrown in a random fashion make an *ad hoc* network. The nodes are cheaper and quite tiny with non-replaceable or rechargeable batteries. So, the limited energy should be effectively utilized for gathering the data for a long period of time. The nodes can send the sensed information directly to the (Base station) BS when the BS is in the communication range of them. However, since the transmission energy needed to send the information is proportionate to the distance to which the information is to be sent, the nodes which are placed far away from the BS lose energies soon. Similarly, some nodes which are still far from the BS cannot send the information directly. The nodes placed closer to each other send almost the same information which is considered as duplicate information. Instead of getting all the raw data from the individual sensor nodes, processed information which states the status of a particular zone is better. In every cluster, choosing the right candidate to be the leader among the nodes is a challenging task since the cluster leader has to do the tasks of receiving data from the remaining nodes, aggregating the data, and sending the aggregated data to the BS[8]. Since taking the cluster head (CH) role is a high-energy consuming process, a single node cannot take the CH role continuously. So, rotating the CHs at right intervals is also a major task.

This work present the state of art performance analysis of "energy efficient routing algorithm based on mobile agent (MA)" designed for wireless networks. However, it is a lot demanding to justice the current position of routing protocol for the particular network state. Based on present investigation parameters such as delivery of packets, the lifetime of the network, and end-to-end delay our work performance is analyzed.

The rest of this paper is organized as follows. Section 2 is composed of the earlier work related to this paper. Section 3 gives the complete information about the proposed algorithm of MAEESCA Section4 about results and discussions. Finally, Section 5 presents conclusion.

II. RELATED WORK

It is evident from the literature that managing energy of mobile sensors is one of the biggest hurdle. A clustered network seems to a promising solution towards an energy efficient solution but data aggregation performed at cluster head is an overhead. Mobile agents (MA) can also play the role of data collector for providing energy efficient network. Various researchers have offered number of ways for data aggregation scheme in sensor networks. Heinzelman, W.B., Chandrakasan [2002] is suggested clustering-based algorithms is set by low-energy adaptive clustering hierarchy (LEACH) [3], it is a way of selecting a set of CHs for each round for optimum performance. Each sensor node calculates a probability threshold value based on optimum percentage of CHs. Then, a random number is generated between 0 and 1 and it is compared with that threshold value. If the random value is less than the threshold value, the node can act as a CH. LEACH uses local data compression to send only the consolidated data to the BS and the load is uniformly distributed among the nodes. Authors Younis, O., Fahmy, S [2004] have hybrid, energy-efficient, distributed clustering (HEED)[4] introduced with the motive of selecting the CHs considering the residual energy of the nodes. Youssef, A., Younis, M., Youssef, M., et al.[2006] Considered, multi hop

overlapping clustering algorithm topology controlled adaptive clustering (MOCA)[5] have highlighted overlapping of clusters but there is high control overhead. Tarhani, M., Kavian, Y.S., Siavoshi, S [2014] observed Scalable energy efficient clustering hierarchy (SEECH)[6] it is probability based on the residual energy separation of CH and relay roles residual energy node degree and it is improved life time but poor load balancing non-uniformed CH distribution. Yuvaraj padmanaban, Manimozi muthukumarasamy [2018] proposed an algorithm called energy-efficient structured clustering algorithm (EESCA)[1], In EESCA algorithm, the parameters such as average communication distance (ACD) and lingering energy are used for the appropriate selection of CHs. EESCSA comprises of 2 modes. In mode 1, the CH is selected based on the ACD. In mode 2, the selection of CH is done based on the residual energy. The CH role is rotated at right intervals based on a new parameter called CH to normal ratio (CTNR) to make the clustering energy efficient. The CTNR is calculated by the ratio of energy spent by the node when acting as CH in mode 1 to the total energy of the node. In mode 1, the nodes which are selected as CHs retain the role of CHs up to CTNR < = threshold value. When a node loses its CH role, it sends the message to the node which holds the next least ACD. After receiving this message, the new node announces its selection to other nodes and continues its operation until CTNR is < = threshold. This process is continued until all the nodes in the cluster gain the role of CH once.

III. PROPOSED WORK

Literature reveals that data aggregation is one of the key solutions for offering energy efficient network that prolongs the network lifetime. Usage of Mobile Agents for data aggregation with result sharing proposed by [own paper reference] conserve the energy by removal of redundant data among sensor nodes and thereby reducing the energy consumption rate of sensor nodes. In this proposed work mobile agents are deployed at each cluster head. After aggregating the data, the selected CH nodes send the data to the SINK, which is an energy consuming task. Already the CH nodes are burdening the data aggregation process. This energy consumption (to send to sink) increases the number of CH rotation, which is cost effective. Here we introduce Mobile Agents (MA), whose role is to collect the aggregated data from the CHs and deliver to SINK. By this, the energy consumption is minimized at the CHs resulting to reduced CH rotation.

Once the CH's are selected, the MA identifies destination CH for each SN based on the distance between them. Selecting the nearest CH for each SN assures the balanced energy consumption among them. Once, this is done the MA broadcasts a cluster head information packet (CHIP) to the entire network which contains information. The SNs receive this packet and interpret it to know their destination CH. Once all the SNs know their destination CH, the MA starts to accomplish its data gathering. The data gathering period comprises of several data collection rounds. In each of these rounds, the MA requires to travel in the target area to carry out data gathering. MA[2] visits the selected CHs one at a time to collect data from SNs. If a SN is within the range of its CH, it directly sends the data to the MA; otherwise it sends the data through its nearest SN. During this process, when MA is about to reach a CH, it broadcasts a polling message with the id of respective CH. Now, SN intended to communicate through this CH prepares and transfers its data to the MA when it reaches there.

Once the MA has collected data from all destined SNs, it moves to next CH. This process continues until all the CHs are visited. The major advantage of the proposed technique is that each SN only requires storing its own data using its own buffer.

IV. RESULTS AND DISCUSSIONS

We have simulated the results using MATLAB and made a comparative analysis discussed below. Also, the simulations parameters are mentioned in the form of table. Refer to table 1.

Table 1.Simulation Results

PARAMETER	VALUE
Application traffic	CBR
Transmission rate	512 bytes / 0.1ms
Radio range	250m
Packet size	512 bytes
Communication range of each SN	25-45m
Initial energy of SNs	100 j
Speed of mobile agent	2m/s
Simulation time	12secs
Number of nodes	26
Area	1000x600
Routing protocol	AODV
Routing methods	SEECH, EESCA, MAEESCA

The merit of a routing protocol is qualitatively and quantitatively judged by the performance metrics.

Algorithm:

N= nodes
ACD= average communication distance
CH= cluster head
RE= Residual Energy
CTNR = CH to normal ratio
MA = Mobile agent
For all nodes N
  Calculate ACD
  Calculate CTNR
End for
While (CTNR [CH] < = threshold)
For Each node N
  If (ACD [N] <ACD [N+1])
  CH = N
End For
If (CTNR [CH] > threshold)
  CH = N+1
End If
End while
For all CH
  MA visit CH
  Aggregate Data
End For

A. *END TO END DELAY:*

Delay is computed utilizing awk content. This metric value determines the delay from Node to Node. The comparison of End-to-End Delay for the Existing, Proposed and Extension is given in Figure 1. And it can be depended on time to vary the output. The performance of the MAEESCA improves delay time it means decrease the delay between

communication nodes compare to EESCA method and SEECH method.

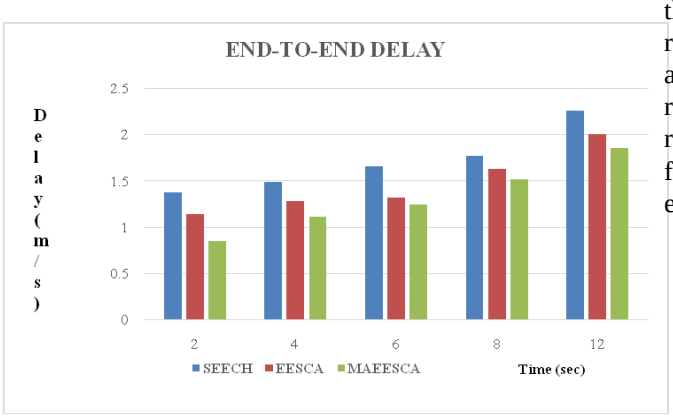

Figure 1: Comparison of end-to-end delay in SEECH, EESCA and MAEESCA algorithm

B. ENERGY CONSUMPTION:

A node loses a specific measure of initial energy for each bundle transmitted and each packet is received. The initial energy utilization level of a node can be dictated by finding the distinction between the present initial energy esteem and beginning energy esteem. The comparison of residual energy for the Existing, Proposed and Extension is given in Figure 2.

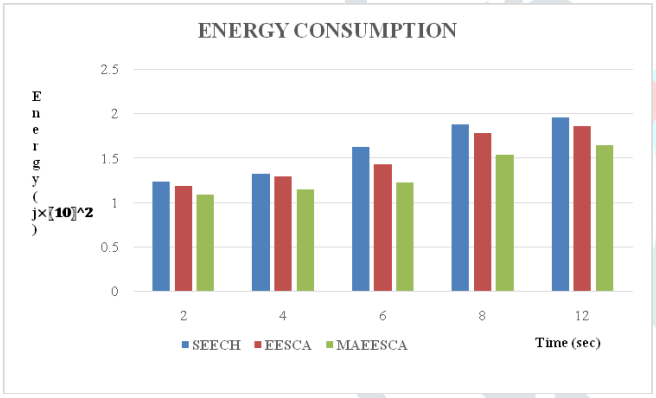

Figure 2: Comparison of energy consumed by the SEECH, EESCA and MAEESCA algorithm

C. NETWORK PERFORMANCE:

The throughput is the maximum rate at which data can be transmitted successfully from sender to receiver. Its units are bits/sec. The comparison of Throughput for the Existing, Proposed and Extension is given in Figure 3.

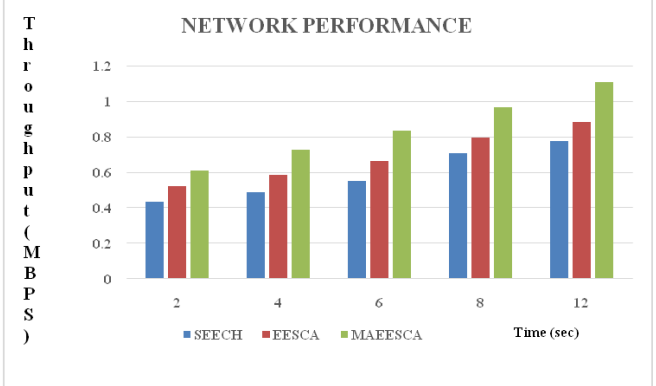

Figure 3: Comparison of Throughput of SEECH, EESCA and
MAEESCA algorithm

V. CONCLUSION AND FUTURE SCOPE

In this paper, we proposed Mobile agent (MA) based clustering algorithm as an addition to the EESCA method that produces energy-efficient WSNs is essential for real-time remote area monitoring applications. The major advantage of the proposed technique is that each SN only requires storing its own data using its own buffer. The partial results achieved so far are highly significant and motivating for further research. Comparison of proposed approach with existing approaches is left for future work.

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