

Energy-Efficient Clustering Algorithm for Wireless Sensor Network Using Mobile Agent

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Abstract

Now a days these wireless communication area is most preferable in many sensing applications like flexibility, suitable, and cost-effectiveness. Modern sensors are used for various purposes to sense the factors present in the environmental and send them wirelessly. To collect data from individual sensors, these data which is collected by the collection centers which is preferable to collect the data from the clustered information from a group of sensors. When we use good and efficient clustering algorithms, so that for the utilizations like speedy communication, good connectivity, and effective data gathering by all these we can ensure them in network. Previously, for environmental monitoring fields we have a effective and simple algorithm is proposed for clustering is called energy efficient structured clustering algorithm (EESCA) is proposed. We select cluster heads (CH) on the basis of selected on their average communication distance and remaining energy. After grouping the collected data, the selected CH node will transfer to the SINK after collecting the data, which will consume the energy task. Already this CH nodes have a burdened process of grouping of the data. This energy consumption will (to transfer the data to sink) increases by the number of CH rotation, and which is cost effective. Here we introduce the Mobile Agents (MA), propose a Mobile agent

based energy-efficient structured clustering algorithm (MAEESCA), whose part be to collect information from the CHs and deliver (send) to SINK. By this, energy utilization be decreased along with CHs resulting to reduced CH rotation. We compare the results with some well-known presented algorithms scalable energy efficient clustering hierarchy (SEECH) as well as energy efficient structured clustering algorithm (EESCA) by this we can prove proposed technique be more efficient for WSNs.

Keywords: WSN, Clustering, Cluster head, LEACH, SEECH, EESCA, Energy efficiency, SINK, MAEESCA.

I. Introduction

Wireless sensor network (WSN) have many things in that we have low-power sensor nodes which be useful for the processing, communicating and capable of sensing. We see these sensor nodes in the field on different points, which are in participation with each other and later they transfer the measured data to the base station (BS). Therefore, in cyber-physical system (CPS) these WSNs play a major role, which are used for observing and also to know the information about it at low cost [1]. However, we have limited resources in the sensor networks, like non-rechargeable energy. To design the network topology we had main issue with energy efficiency which affects the sensor networks lifetime.

To control the topology we had designed a protocol for WSN, by this we increase the network life time by minimizing the energy consumption [2, 3].

We have two types of topology management, they are classified into kinds, among them one as energy management, and next one is hierarchical topology management. For second type of hierarchical topology control, we have 4 techniques, i.e., one is clustering techniques (e.g., [4–6]), second is associated control situation technique (e.g., [7–11]), third is spanning tree methods (e.g., [12–14]), with last the fourth is spanner methods (e.g., [15, 16]).

The surrounding environment is sensed and gathered the information surrounded by it (computation) and sends to base station (BS) by using the sensor nodes. In the process of communication while send to BS it consumes lot of battery power and out of these three types, we face with the major issue i.e., with the communication. By decreasing the cost of communication, we can save battery power. Majorly we have four components in each and every sensor nodes in network -i) sensing unit, ii) transceiver, iii) processing unit as well as iv) the power supply. Some other elective components of sensor nodes consist of i) region finding machine, ii) electricity generator and a iii) mobilizer.

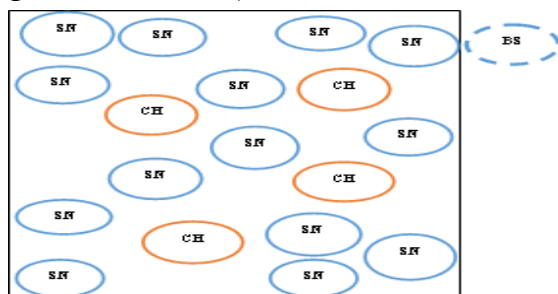


Figure1: Example wireless sensor network model

In By reducing the energy consumption we can increase the network life time in the

WSN for the effective topology control these is the best method, one of the important way is clustering. In the network all these sensor nodes are grouped into clusters, then in each cluster we are choosing one of the nodes as leader that is within the cluster and named as the cluster head (CH), and remaining nodes are called cluster members (CMs) in this clustering scheme this will measure the parameters which are associated to its atmosphere as well as then transfer to their CHs. This CMs collect all the data which is arrived and then CHs reduce data and send to BS.

CHs have a responsibility to receive and gather the information from their CMs can transfer the gathered information to particular purpose, here energy utilization of CHs are more while comparing with CMs. Thus, to solve this type of problems, we choose the appropriate cluster heads and we have a key issues while coming to designing a cluster protocol. Here lots of energy is consumed when the CHs send the gathered information to the BS directly, because it has a long-distance transmission due to this it leads to the early death of CHs. Thus, major object of a clustering protocol designing is to have appropriate inter-cluster multi-hop routing tree to forward information.

The main problem is limited energy in wireless sensor network, this is thought to be used to gather the information effectively for long period of time. The major issue is cluster head rotation in the network, in the clustering techniques. To overcome these problems we have many schemes such as LEACH, SEECH, HEED, and EECS. In this project, we use the mobile agent mechanism i.e., the cluster head selection to select the efficient CH

selection in wireless sensor network and we use AODV protocol to make routing along with transfer data between cluster head and the base station with the help of mobile agent.

This paper presents a mobile agent based energy efficient structured clustering routing protocol called as MA-EESCA. The MA-EESCA uses the parameters like the average communication distance and energy for selecting cluster head to select energy level routing. This routing method works by the mobile agent.

II. Related work

In [17], author proposed the designing of a WSN i.e., sensor nodes which are with security, low cost, clustering utilization, self-configuration ability, fault tolerance, low power consumption, small size, adaptability, reliability, and the Quality of service (QoS).

In [18], author proposed by observing the many researchers are done on the diverse cluster based totally routing protocols. In the clustering protocols, the information accrued via sensor nodes are present in same cluster and sends data within cluster called cluster head and mainly it is used to remove the relevant data to reduce final data volume and send the gathered data to the data sink.

In [19, 20], author proposed a Low energy adaptive clustering hierarchy (LEACH), CHs are rotated randomly because in the network every sensor node should have the energy load. By probability scheme the CHs' selection has done, after these every node will defines about the selection of the CH whether it is there or not on the basis of the random number generated by itself.

In [21], author proposed a distributive clustering algorithm i.e., the Hybrid energy efficient distributed clustering (HEED), based on a some probability which is related to hybrid of energy and communication cost by considering all these conditions we select one of the sensor node as the CHs.

The new method has introduced i.e., SEECH (Scalable Energy Efficient Clustering Hierarchy Protocol method) here if the distance is long between the sink and the CH, then we consider the packet to transfer by choosing the nearby relay node or else these CH will transfer the data to the sink. We have simple procedures in this method which will decrease the complexity and execution time by selecting CH and relay. We include interruption recognition of this SEECH system will increase system highly efficiently under regions of intelligent traffic system (ITS); where this intruders be able to generate this incorrect or misleading message network may send to base station; this influenced the further dispensation as well as assessment creation. Major feature is safety which is comprised following [22].

In [23], author proposed energy-efficient structured clustering algorithm (EESCA). In EESCA algorithm, we select this CHs on the basis of few parameters like average communication distance (ACD) and lingering energy. EESCA consist of 2 modes. In mode 1, by using this ADC we select the CH. In mode 2, by using the residual energy we select the CH. This CH involvement is to rotate to right intervals on the basis of new parameter referred to as CH to normal ratio (CTNR) which makes the clustering energy extra green. The ratio of energy spent by the node when acting as

CH in mode 1 to the whole energy of the node is calculated for CTNR. We check the conditions on the basis of threshold. This process will continue till all nodes present in cluster should increase involvement of CH at least one time.

III. Proposed system

MAEESCA - Mobile agent based energy-efficient structured clustering algorithm:

Considering the network model as follows:

- i. In WSNs, for sensor fields we consider the M sensor nodes in scattered manner. The operation situation is as shown in the Figure 1; here the sensor field is in the square area and it has its side as 'L' at a distance 'd' from alone fixed base station.
- ii. We have limitations for M sensor node in memory space, battery power, and processing power.
- iii. We have fixed M sensor nodes and they are grouped physically into clusters. Here we have two functions: cluster head or sensing. Each CH have functions and are scheduled and uses the multi-hop routing, they are intra cluster and inter cluster communications, records aggregation and information forwarding to the base station. On the alternative hand, this cluster head cannot perform the sensing manner. In the cluster the motive of cluster head is to rotate between the non-sensing nodes. Otherwise, a sensing node is dynamically sensing the situation or it's far in the inactive mode if it isn't sensing. The Base station will decide which node to apply for sensing tasks.
- iv. The sensed records by means of sensing nodes inside the cluster are broadcasted straightly to their cluster head that later it gathers and/or that statistics is

send to every other cluster head, for you to ship immediately to the bottom station. This sensor nodes and the base station isn't with the limited assets so communiqué is immediately forward from the bottom station to the sensor nodes.

v. In the sensor field we have nodes in the network and the position of each node and its information is known to the base station.

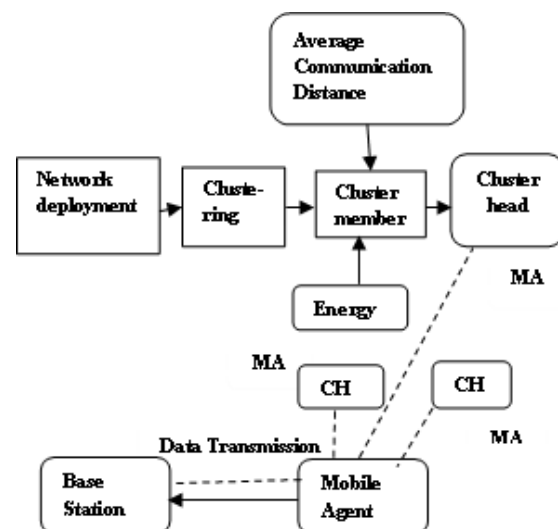


Fig2: Flowchart of Proposed system

After gathering the data, the SINK node receive the data from the selected CH nodes, which is an energy consuming task. Already it is burden for the CH nodes with the data gathering process. Due to this energy consumption (to send to sink) the number of CH rotation are increased, which is cost effective. Here we introduce Mobile Agents (MA), whose involvement is to collect and to reduce the data at SINK node which is received from the CHs. By this, the energy consumption is reduced and the CHs rotation. After selecting the CHs, the MA identifies the destination the CH for each SN on the based distance

between them. By selecting the nearest CH for each SN we can guaranty the balanced energy consumption among them. After the above process this MA broadcasts the cluster head information packet (CHIP) to the whole network which contains information.

The SNs receive this packet and interpret it to know their destination CH. After every SNs knows their destination CH, the MA starts gather the data. The information gathering duration consists of of several information series spherical it. In a lot of these rounds, the MA calls for to tour inside the goal region to perform information collecting. MA will visits the chosen CHs one time to accumulate statistics from SNs. If SN is inside the range of its CH, it sends the statistics to the MA directly; or else it'll sends the facts thru its nearest SN. During this system, when MA is near by way of the CH, it announces the polling message with the identity of respective CH. Now, SN will transfer the data to MA when it reaches and it communicates through this CH only. After collecting the information by the MA from all destined SNs, next it movements to the next CH. This keeps till all the CHs are visited. The primary gain of this proposed method is each SN stores its own data by using its buffer. Figure 2 shows that block diagram of proposed system.

Algorithm Process:

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

IV. Results and Discussion

Performance calculation and comparisons of proposed scheme, MAEESCA, against EESCA and SEECH have done by using network simulator NS2. The metrics we consider for the performance calculation and comparison are Energy consumption (EC), Average End to End Delay (E-to-E Delay), and Throughput. Simulation parameters are illustrated in Table 1.

Table 1: Simulation table

Simulation Parameters	Values
Simulation Tool	NS-2.35
No.of nodes	26
Simulation time	12 seconds
Simulation area	1000x600 m
Radio range	250m
Communication range of each SN	25-45m
Mobility model	Random waypoint model
Routing protocol	MAEESCA
Packet size	512 bytes
Transmission rate	512 bytes / 0.1ms

Speed of Mobile agent	2m/s
Channel type	Wireless
Mac layer	802.11
Traffic type	CBR
Antenna type	Antenna/Omni antenna
Initial energy	100 j

Network Simulator (NS2) model 2.35 is used to bear in mind and analyze the proposed concept. Simulation consists of 26 nodes inside the vicinity of one thousand x six hundred m2. Here we're going to use Random Way Point (RWP) mobility and the variety of transmission is about to 250m for best unstructured. Nodes are moving with the common velocity of 2m/s. Two scripts are used, the first (code.Tcl) for random generating traffic for regular Bit Rate (CBR) of 512 bytes in keeping with UDP protocol and the second one (Setdest) to provide mobility eventualities. Simulation time is units to 12 s for all assessments.

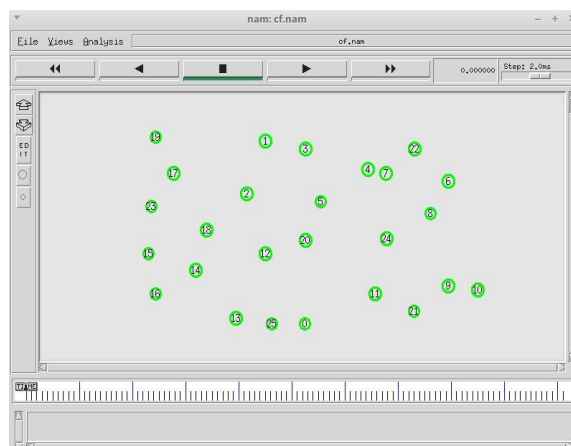


Fig3: Network deployment

In above figure 3, showing that all nodes in the network are placed correctly and we deploy properly in the network. Here we displayed all the nodes based up on the topology values and it should accept all the properties of NAM window.

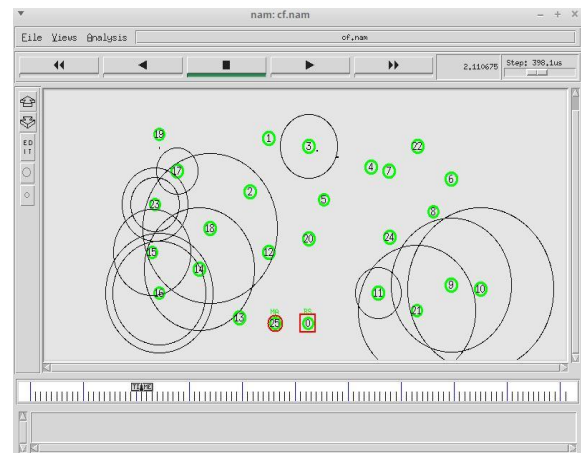


Fig4: Broadcasting in network

In above figure 4, shows us the broadcasting of the throughput of the network, this is for communication purpose so all the nodes are involved in the process.

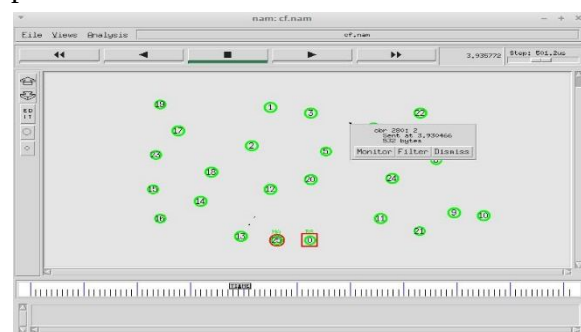


Fig5: Data transmission between cluster member and cluster head

In above figure 5, shows us the data process with the help of traffic protocol and communication between the cluster members and the cluster head.

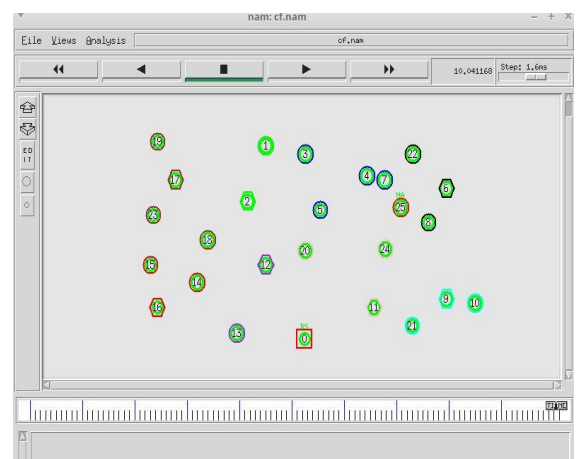


Fig6: Mobile agent moving to different location-while data process

In above figure6, show us during the data transmission from cluster heads in the network these mobile agent can move and also stay in some other location.

```
Cluster - 1 : 14 15 16
Cluster - 2 : 12 13
Cluster - 3 : 11 20 24
Cluster - 4 : 9 10 21
Cluster - 5 : 17 18 19 23
Cluster - 6 : 1 2
Cluster - 7 : 3 4 5 7
Cluster - 8 : 6 8 22

##### Round - 1 #####

=====
Energy of node 14 99.930454
Distance from node 14 to its neighbour 14 15 16
0.000000 136.014705 125.299641
Energy of node 15 99.930454
Distance from node 15 to its neighbour 14 15 16
136.014705 0.000000 101.980390
Energy of node 16 99.930454
Distance from node 16 to its neighbour 14 15 16
125.299641 101.980390 0.000000

Cluster Head(CH) is node : 14

=====
Energy of node 12 99.913490
Distance from node 12 to its neighbour 12 13
0.000000 178.885438
```

Fig7: Cluster file –round1

Figure7 represents it has eight clusters in the network which formation is updated with time. The CH selection process involved on the basis of distance between the neighbors in the network and residual energy. After calculating the distance, the cluster head is decided by the cluster member by having the lowest distance in the network while compared to other members in the network. This process should work in round no.1.

```
s 2.000000000 16 AGT --- 0 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [16:0 15:0 32 0] [0] 0 0
r 2.000000000 16 RTR --- 0 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [16:0 15:0 32 0] [0] 0 0
s 2.000000000 12 AGT --- 1 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [12:0 13:0 32 0] [0] 0 0
r 2.000000000 12 RTR --- 1 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [12:0 13:0 32 0] [0] 0 0
s 2.000000000 9 AGT --- 2 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [9:0 10:0 32 0] [0] 0 0
r 2.000000000 9 RTR --- 2 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [9:0 10:0 32 0] [0] 0 0
s 2.000000000 19 AGT --- 3 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [19:0 18:0 32 0] [0] 0 0
r 2.000000000 19 RTR --- 3 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [19:0 18:0 32 0] [0] 0 0
s 2.000000000 2 AGT --- 4 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [2:0 1:0 32 0] [0] 0 0
r 2.000000000 2 RTR --- 4 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [2:0 1:0 32 0] [0] 0 0
s 2.000000000 7 AGT --- 5 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [7:0 3:0 32 0] [0] 0 0
r 2.000000000 7 RTR --- 5 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [7:0 3:0 32 0] [0] 0 0
s 2.000000000 8 AGT --- 6 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [8:0 6:0 32 0] [0] 0 0
r 2.000000000 8 RTR --- 6 cbr 512 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [8:0 6:0 32 0] [0] 0 0
s 2.000000000 16 RTR --- 0 AODV 48 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [16:255 -1:255 30 0] [0x2 1 1 [15 0] [16 4]] (REQUEST)
s 2.000000000 12 RTR --- 0 AODV 48 [0 0 0 0] [energy 100.000000 ei 0.000 es 0.000 et 0.000 er
0.000] ----- [12:255 -1:255 30 0] [0x2 1 1 [13 0] [12 4]] (REQUEST)
```

Fig8: Trace file in network

In above figure 8, trace file represented. Here total information is presented for nodes like, node data, energy level updates of nodes displayed, time intervals for sending the packets, routing process.

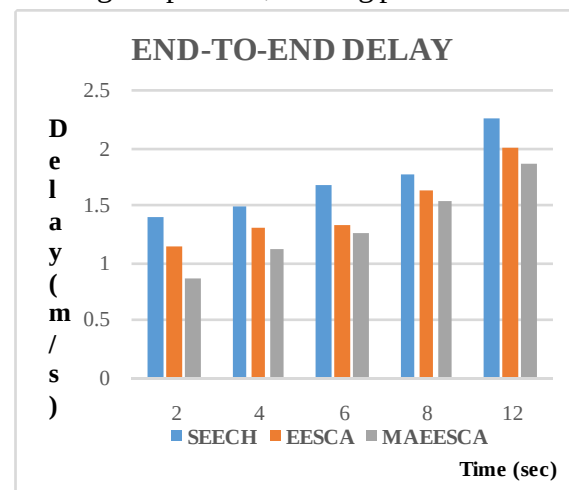


Fig9: End to End Delay

The above figure9 represented as End to End Delay, and the output may vary by depending on the time. The performance of the MAEESCA improves delay time, it means by decreasing the delay between communication nodes while comparing

with the EESCA method and SEECH method.

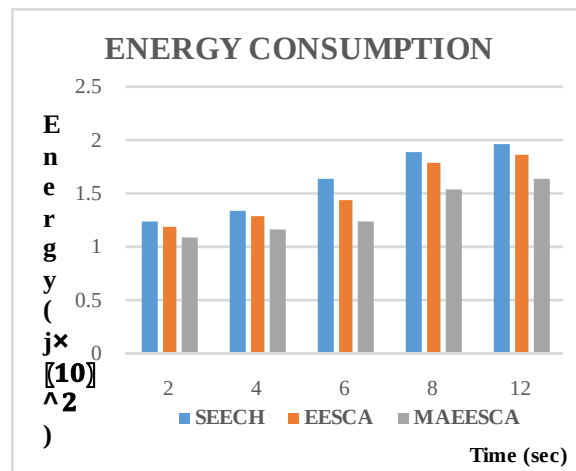


Fig10: Energy consumption

The above figure10 represented as Energy consumption and the output may vary by depending on time. The performance of the MAEESCA improves energy consumption time it means by increasing the energy levels and decreasing the energy consumption while comparing to EESCA method and SEECH method.

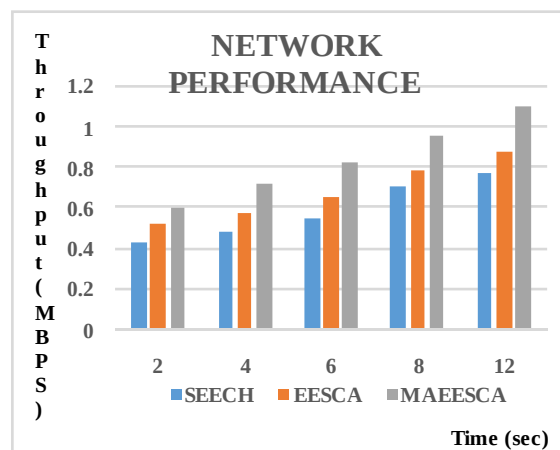


Fig11: Network performance

The above figure 11 represented the Throughput, and output may vary by depending on time. The performance of the MAEESCA improves the throughput while comparing with the EESCA method and SEECH method.

V. Conclusion

Proposed method is Mobile agent which is based on energy-efficient structured clustering algorithm for WSNs is crucial for real-time in the remote area monitoring applications. In this paper, these mobile agents are introduced to collect the aggregated data from the CH's and deliver to the SINK. MAEESCA is very simple and it reduces the energy consumption near the CH's which resulting to reduce the CH rotation. Specifically, simulation results show that the MAEESCA is more efficient than existing methods.

As per future scope, basically in the routing, a node will forward the message to the subsequent node that is closest to the vacation spot. If the base station receives many messages dispatched by the nodes, there may be a excessive chance that the intermediate nodes receives duplicate messages from the same goal occasion because of the waft path of the message is one-way. By calculating the source nodes we can identify the duplicate messages from the target location. This duplication occurs everywhere in the network not only at the source node but at every intermediate nodes in the network. So we are introducing backup and duplication based fault tolerance routing method and by this we reduce the duplicate messages and then increase the delivery ratio.

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