© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Fault Tolerant Routing Algorithm for Internet of Things(IoT) by using Nature Inspired Computing(NIC) Techniques

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ABSTRACT

To minimize energy consumption and maximize the network lifetime is main objective of clustering for Internet of Things. In clustering the transmission and receiving of packets towards from source node to destination node is affect of energy consumption. In clustering, the cluster head receiving the data and packets from other sensor nodes in a group. While receiving all data from other nodes it will transfer to base station. By the way the cluster head loose its energy and also damage early by transferring huge load of messages by sensor nodes to base station. The objectives of this paper is first, to share out routing burden to all CHs in cluster to the base station second, increase lifetime of clustering network third, introduce fault tolerant problem because of huge data routing of cluster heads occurs unexpected damage. By applying nature inspired computing algorithms solve these problems in clustering for internet of things approach.

Keywords – Clustering, Routing, cluster head (CH), fault tolerant, Internet of Things(IoT),inspired computing(NIC).

I. INTRODUCTION

Ability of fault-tolerant approach in clustering is an critical issue for applications of Internet of Things(IoT) like weather forecasting, agriculture, medical, army etc.[1] This is an encourage towards researchers for solving for every research objective. In clustering approach, sensor nodes monitor, collects information from objects and process the collected information after that it send to base station. The limited capabilities of sensor nodes are having battery life, memory, power for that increase life-time of nodes is challenging task in clustering for Internet of Things approach. So, the cluster head have more energy, processing capacity when compare with other nodes in a cluster. These cluster heads have heavy power for transmit data and improve life-time of network[2,3]. The main problem is, these cluster head also posses operated by battery, having limited constraint of energy. By continuously collecting the data from other nodes, processing in multi-hop network environment due to huge burden of cluster heads damage early. It will effect operation of network efficiently and decrease network lifetime. To face these problems, load balancing and fault tolerant routing is a challenging task in clustering for Internet of Things approach.

There are n gateways and average of Avg next hop gateways, exist Avgn no. of valid routes to base station is a huge for large scale clustering. For optimizing of this problem by applying Particle Swarm Optimization (PSO) is a nature inspired computing algorithms to solve best way to meet optimum results.

In proposed work, by applying PSO is a nature inspired computing algorithm for solve routing in internet of things. By failure of network for any reasons, the effective restore of connecting gateways to the base-station. The proposed algorithm is better performance than that of existing work by showing in simulation results. Proposed paper organizes as like. In section2, written related work. In seciton3, written network model. In section4, written algorithm for proposed work. In section5 results of experiments and showing simulation results by graph. In section6, written conclusion.

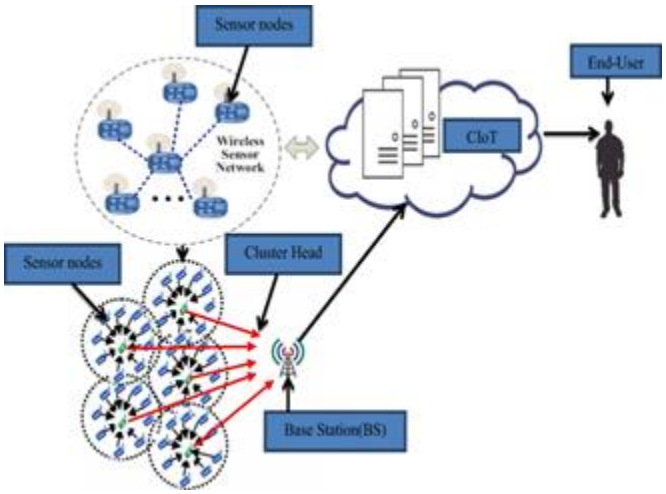

Fig1 – Clustering in Internet of Things (IoT)

II. RELATED WORK

In[4] paper providing survey information about protocols for sensor network are. The routing protocols are for data-centric, hierarchical and location-based. In[5] proposed LEACH is a single hop routing algorithm for apply load balancing by dynamic rotate of workload of cluster heads include with nodes. In this approach, the dis-advantage is the cluster head is quickly damage due to selection of this cluster head with low energy. In[6] proposed an algorithm recovering of every node depend upon distance between every node from cluster-head nodes. The cluster heads recovery is depend upon remaining energy of cluster head. In[7] proposed routing for Genetic Algorithm concentrate only on shorten distance from cluster head to base-station. But not considering the fault tolerant approach. In[8] proposed routing of Genetic Algorithm by selection roulette-wheel along with fitness function the choose of individuals. But not considering the fault tolerant approach. In[9,10] proposed routing algorithm for fault tolerant issues by using meta-heuristic algorithms.

In[11] proposed (differential evolution based routing algorithm(DE) concentrate on which cluster-head consuming maximum energy is minimize. But not show any research for identify approach for solving if cluster head failure due to heavy load. In[12] proposed energy aware fault-tolerant routing. For saving energy nodes in a network present in un-used path are in sleep mode. By applying mixed cross-layer and learning automata(LA) based fault-tolerance protocol for sending packets from source to destination in a network of IoT even in faults occurs. In[13] proposed fault routing approach in a critical reasons for existing method. In the area of resource management, resource allocation the fault tolerant approach introduce in internet. In[14] proposed hybrid routing method in that alternate path are established when previous route is broken. The authors apply particle swarm optimization(pso) for quick route recovering for intelligent fault-tolerance in internet of things approach. In[15] authors proposed survey on fault tolerance and fault detection in wireless sensor Networks.

All these existing work use nature inspired computing algorithms concentrate only minimize energy consumption and balance route load only. But not include fault tolerance approach if any routing, network problem occurs for huge load on cluster head by collect and transferring huge data to base-station in clustering for internet of things approach.

III. NETWORK MODEL

In a network model is describe about sensor nodes, cluster head, energy constrain concepts. The nodes are not moved after located either manual or random. The wireless communications are proposed in this network model with exactly links are similar. As per receiving of signal capacity, distance will be estimated between sensor nodes in a clustering approach.

- The cluster heads indicate by CH = $\{ch_1, ch_2, \ldots, ch_n\}$
- The base station indicate by ch_n
- The remaining residual energy(ch_i) indicate by $E_{res}(ch_i)$
- The maximal communicate limits nodes and cluster head by C_{max}, Avg_{max}.
- The Next_Hop(ch_i) is gateway (ch_i) is selected as next-hop gateway by ch_i
- in routing approach towards base station.
- The next hop is base station this base station within range of ch_i.

IV. PROPOSED MODEL

The centralized model for routing algorithm is at starting, every node and cluster head in clustering network approach allotted an unique ID by base station by boot-strapping method(self starting process). By using media access control(MAC) layer protocol each sensor node and cluster heads broadcasting own ID. The cluster heads within their communication limit of Avg_{max} and CL_{max} collect all sensor nodes IDs. To construct network setup, every cluster heads passing these information to base station within network. The two methods are setup phase and study phase is to setup for network. The final routing method is proposed by base station in the setup phase. After completion of route setup phase, about next hope of cluster heads towards the base station this information passed to base station. The next phase is steady-phase is limit by 75-100 rounds. In every round, cluster heads collect data from sensor nodes and send these data to base station. This method is continuously till finding route from cluster head to base station.

For solving above problem, by applying Particle Swarm Optimization(PSO) of Nature Inspired Computing approach. The objective of this proposed paper is, minimization of energy consumption, maximization of network, and proper allot routing load to the cluster heads in a clustering network for internet of things.

The network information receiving by base station then starts routing load for every cluster head in a clustering network. As per round, the total number of packets TOP_{rec} received by every cluster head ch_i.

$$TOP_{rec}(ch_i) = \sum\{TOP_{rec}(ch_j) \mid Next\_Hop(ch_j) = ch_i, ch_j \varepsilon CH\}, If\ Next\_Hop(ch_j)=ch_i, \forall ch_j \varepsilon CH \\ 0, \text{otherwise} \quad (1)$$

If E_R, $Energy_{rec}(ch_i, Next\_Hop(ch_j))$ and $Energy_{intra\_clu}$ is values for energy consumption about cluster heads for receive, send data to further hop cluster head also energy-consumption of cluster head ch_i oving to intra-cluster process as receiving data from nodes and aggregate these data. For that reason, consumption of energy of cluster head ch_i is $Energy_{consum}$ for routing of data for one round as describe...

$$Energy_{consum}(ch_i) = TOP_{rec}(ch_i) \times Energy_{Round} + (TOP_{rec}(ch_j) +1) \times Energy_{rec}(ch_i, Next\_Hop(ch_j)) + Energy_{intra\_clu}(g_i) \quad (2)$$

In above equation by adding one in data transmission the reason is cluster head having cluster heads' data after aggregation data receive from nodes. For this LifeTime(LT) of ch_i with residual energy(i.e. remaining energy) $Energy_{rec}(ch_i)$ calculate as...

$$LT(ch_i) = \frac{Energy_{rec}(ch_i)}{Energy_{consum}(ch_i)} \quad (3)$$

The proposed objective of this paper is minimization conservation of energy via balance of route load. By this approach only maximization of cluster heads is possible. And also lifetime will be increased only by minimizing route load on cluster heads. As per this, the formula like…

$$Max\_LT = \min\{LT(ch_i) \mid \forall ch_i \varepsilon CH\} \quad (4)$$

Fault Tolerance - In process of steady phase, next hop cluster head of cluster head fails, automatically cluster head select another cluster head towards base station to further process. If any data is not receiving, the cluster head acknowledge from its next hop cluster head[17]. The HELP message broadcasting by cluster head for finding a faulty next hop cluster head. Automatically all neighboring cluster heads gives replied to HELP message. Towards base station, the cluster head joined a cluster head with extend lifetime. Or the cluster head is treated as damage.

TABLE1- Parameter Settings

No. of sensor nodes	600
No, of cluster heads	60
Deployed area	500 x 500 square meter area
Base station co-ordinates	500, 250
Initial energy	2J and 10J
Particles	60

Particle Swarm Optimization(PSO) routing algorithm…

Input: (1) Set of gateways $CH = \{ch_1, ch_2, \ldots, ch_n\}$ and $Next\_Hop\ (ch_i)\ \forall_i, i \le i \le n$

Output:

(2) Route R: CH→{CH+ ch_{n+1}} Predefined swarm size N_{pre}.

Step 1: Initialize particles I_{pi}, $\forall_i, i \le i \le N_{pre}$

Step 2: ***for*** $i = 1$ to N_{pre} ***do***
: Calculate $Fit(I_{pi})$ /* Using equation 3.*/

: $P\_best_i = I_{pi}$

end
Step 3: $G_{best}=\{P\_best_j \mid Fit(P\_best_j) = \min(Fit(P\_best_i), \forall_i, i \le i \le N_{pre})$
}

Step 4: while
(!(terminate))

for $i = 1$ *to* N_{pre}
do
: Update velocity and position of I_{pi}

: Calculate $Fit(I_{pi})$

: *If* $Fit(I_{pi}) < Fit(P\_best_i)$ ***then***

$P\_best_i = I_{pi}$

end

: *If* $Fit(P\_best_i) < Fit(G_{best})$ ***then***

$G_{best} = P\_best_i$
end
end
end

Step 5: Calculation of $ch(ch_i)$, $\forall_i, i \le i \le n$ (i.e., route *R*) using G_{best}.

Step 6: Stop.

In Fig2(a) in proposed algorithm shows number of cluster heads dead. By applying proposed algorithm first cluster head die after a long period. This efficiency reached because of distribution of route loading on cluster heads. That is also which cluster head nearer to the base station for that reason the immediate die of cluster head is minimized. The restoration connection of cluster heads which next hop cluster heads reach faulty status in routing time period. Fig2(b) shows while comparing of dead of sensor nodes are very less in EEFTRA when comparing with existing algorithms GAR, GA.

TABLE2- No. of Dead Cluster Heads (CH)

No. of rounds	EEFTRA	GAR	GA
0	0	0	0
500	0	3	4
1000	0	9	11
1500	3	18	20
2000	58	53	48

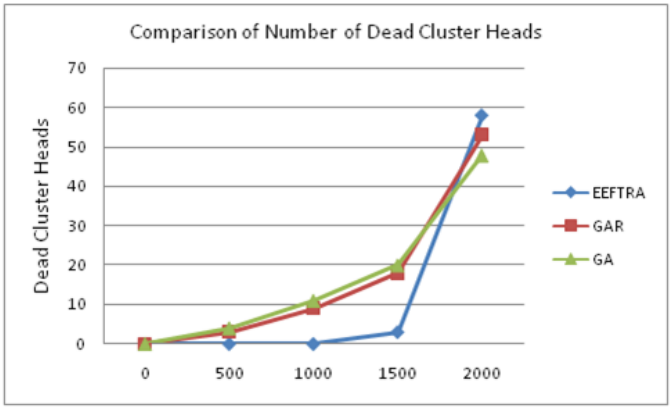

Fig-2(a) Comparison of number of dead cluster heads

TABLE3- Comparison of no. of Dead Sensor Nodes

No. of rounds	EEFTRA	GAR	GA
0	0	0	0
500	0	10	15
1000	0	100	105
1500	0	200	180
2000	580	550	540

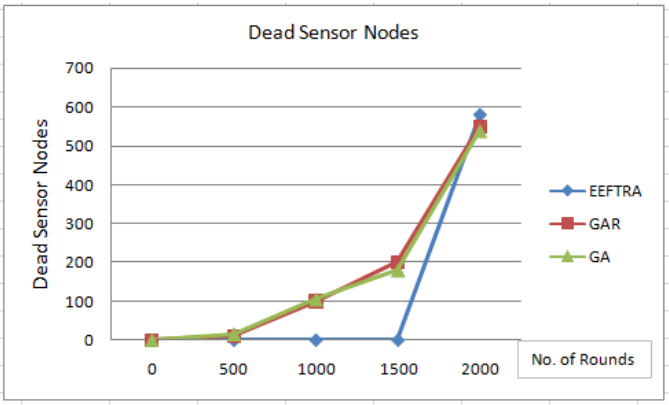

Fig -2(b) Comparison of dead sensor nodes

In Fig3(a) shows in proposed algorithm, the residual energy of cluster head is very less when comparing with existing algorithms. It is happening in proposed, minimization of the consumption of energy of cluster head by share route load among all cluster heads. In this way in proposed algorithm balances the consumption of energy in a clustering network. In Fig3(b) shows total no. of data packets received by base station is higher and also no. of alive cluster heads higher in the clustering network for internet of things.

TABLE4 – Residual Energy of Cluster Heads

No. of rounds	EEFTRA	GAR	GA
0	0	0	0
500	0.8	2.2	2.4
1000	1.6	2.6	2.9
1500	2.1	2.3	2.75
2000	2.2	2.25	2.6

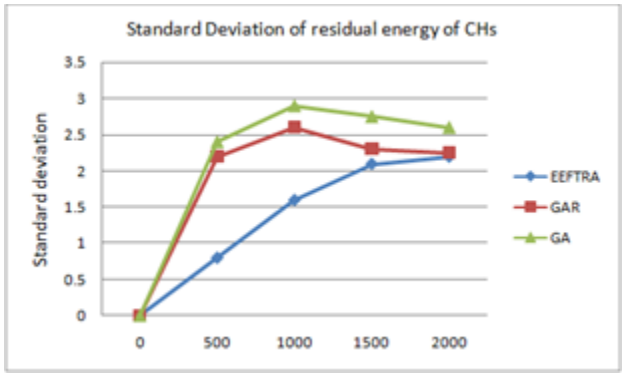

Fig3(a) Standard Deviation of Residual Energy

V. CONCLUSION

This paper propose Energy Efficient Fault Tolerant Routing Algorithm(EEFTRA) by particle swarm optimization(PSO) of nature inspired computing algorithm to maximization of lifetime of clustering network is possible by minimization of energy consumption of cluster heads. In this approach, which cluster head is nearer to the base station by share the route load among other cluster heads. The proposed algorithm extent efficiency of concept of fault tolerance approach of cluster heads. The proposed algorithm is better when compare existing algorithms regarding to total number of die cluster heads, total number of die sensor nodes, total number of packets received by base station and residual energy of cluster heads. The proposed algorithm concentrate on well establish of route and cluster head's fault tolerance approach by reaching these proposed objectives they are first, by distributing load balancing of route among all cluster heads in a network and reach minimize of energy conservation second, performing load balancing of route share among all cluster heads with this minimize burden to cluster heads for sending receiving packets third, maximize the lifetime of cluster heads and minimize the number of die of cluster heads.

VI. ACKNOWLEDGEMENT

I would like to special thanks and gratitude to my supervisor for his valuable guidance and blessings towards completion of my research paper. My thanks and appreciations also for my dear colleague and friends their willingness help me for successful completion of my paper.

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