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Secure and Efficient Fire-fly Data Routing Algorithm for Wireless Sensor Networks in IoT Monitoring Systems

R. Kowsalya¹, Dr. B. Rosiline Jeetha²

¹ Assistant Professor, Department of Computer Science (PG)

¹ PSGR Krishnammal College For Women, Coimbatore, India

² Associate Professor & Head, Department of Computer Science

² Dr.N.G.P. Arts and Science College, Coimbatore, India

2017ngpphd@gmail.com¹, jeethasekar@gmail.com²

Abstract. In the Electronics world the sensor is used in IoT applications. The sensed data need to be transfer to the appropriate devices as input for further processing. Clustering used to group the sensors which could form cluster and select the nodes head from the cluster. The head of each cluster receives the forwarded data through the cluster member and pass on to nearest permanent fixed station. Identifying cluster head and shortest route identification is a major challenge. This paper proposed a novelty on hybrid decision making algorithm with firefly routing algorithm (HDMFRA) for Cluster Head selection. This research work focusing of three main criteria which could save the energy and extend the life activation of the node, through the usage of energy, amount of nodes adjacent and energy consumption from permanent fixed station. To aggregate the data in optimized manner and to transfer the data in efficient manner Fire Fly routing algorithm was used. Simulation results show that proposed algorithm HDMFRA network in homogeneous environment is effective and prolonging the life time of the node by 25%.

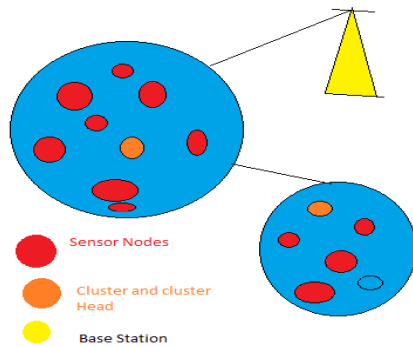
1. Introduction

IoT is a networks which connects the object together. In urban areas for promoting new developments and functions IoT related applications were developed as it is technological revolution which connects the real world of physical devices in which wireless sensor plays a vital role to communicate and response according to the needs of the applications [1][12]. Sensor are very small and consumes very low-power. Inorder to transfer the data quickly the cluster head was needed which could decreases the utilizing of energy will be less and effective [2][14]. The active time of the sensor node will be more when the node utilized in the short network or by the non-hazardous areas. Replacing the battery of sensor in hazardous areas was very difficult. During sensor nodes in active stage at each moment there will be depletion of energy. Activating the data in the sensor and passing the data towards base station will consume more energy, Failure of single sensor nodes destruct whole networks [15]. As the Network lifetime depends on each node design the network in such a manner that energy should be efficiently used by the network. Huge amount of nodes and permanent fixed station [17] will form wireless sensor networks. More energy will be consumed when there was a communication between the sensor nodes every time with their neighbouring nodes.

The data sensed by the sensor of different application such room temperature monitoring system in intensive care unit called source networks and the base station called as the sink nodes. A sensor networks utilizes the limited energy supply in conventional sensor networks. Energy consumption will



be saved when multi-hop communication was used. Consumption of the energy, will be directly proportional to the square root of the distances when it traverse through a shortest distances. In order to achieve continuous data sensing the protocol for routing [16] and data aggregation should be in well formed. According to the application deployed the protocol should be varies.



In order to Grouping nodes the clustering techniques was used. Base station receives the data from header node which aggregates from the other nodes [17]. Scheme of selecting energy efficient cluster head and optimized data aggregation was focused. At every time partition and the cluster head selecting would help IoT monitoring systems to lead more life time. The ordering of the paper includes Section 2 elaborates the previous work carried, novel proposed work discussed on Section 3; Section 4 includes simulation results and Section 5 holds result conclusions.

Figure 1. Group Clustering, Fixed Station

2. Literature Survey

M. Bani Yassein, A. Al-zou'bi, Y. Khamayseh and W. Mardini[3]. describes that in order to consume less energy utilization and prolonging life time of sensor network, routing protocol should be adapt in according to the changing of the topology in the mobile sensor networks. LEACH protocol optimizes the energy only for the static sensor networks and it could not be used for dynamic sensor networks. Xiaoyan Cui [4] states the LEACH-M is used for dynamic sensor networks as there were more movements of nodes the energy consumption of traversing of the node was more and due this energy consumption was also high.

Kulkarni, R. V, Venayagamoorthy, G. K [5]. Describes the issues in the designing a wireless sensor networks are memory to store the data, energy constraints, bandwidth and limited capabilities. The issues can be solved by the optimization techniques to find the solution [5]. Aziz *et al.* [6] Focuses on controlling the topology and extending active phase of wireless sensor networks, the clustering was used and the selection of the neighbour based on the set of rules such as density of the network and energy reserve for each node.

Abbasi *et al.* [7]. Based on the sorting of variable and constant converge time various clustering algorithm was summarized and it was also compared with the location awareness and the cluster mobility and stability. Bajaber, F., Awan, I[8]. Cluster head was selected by the power of each node holds and every round of selection it includes two phases they are preparatory phase and round phase. Preparatory phase represents distance between the Permanent fixed node and high active energy node. The base station will divides the networks in cluster and selects the cluster head. In round phase aggregates the data received from nearest cluster by the cluster head and passes through base station. Reclustering and choosing of the cluster head will be done by the nodes without any intervention of base station, and again it starts its intial stage, Reclustering will be avoided for the few stage, so there will be unbalanced among the nodes.

Vijayalakshmi, K., Anandan, P[9]. shows the issues of sensor networks in hierarchical routing protocols. Behera, T. M., Mohapatra, S. K., Samal, U. C., Khan, M. S., Daneshmand and M., Gandomi, A. H [10] Distribution of the nodes will optimize usage of the energy resources of the networks. The wrong choosing of cluster head will deplete the energy resources. W.Heinzelman, A. Chandrakasan and H. Balakrishnan[11] states in "LEACH" very large and very small cluster may be

exist at the same time. When there is a depletion of the cluster head the cluster member node will also be depleted. The LEACH algorithm does not take the parameters of location based cluster selection.

3. System Model

LEACH-M protocols have set-up state and steady-state phases. Set-up phase sensors organize and select a cluster head as constant throughout its active stages. Cluster head moved to dead state when there was overloading in the networks. To overcome the drawbacks LEACH protocol selects the cluster head by rotation among the cluster members. In LEACH it reduces the energy by data fusion so; there is an increase of the network life time which would be reducing the energy dissipation.

Through the probability decides which node could be cluster head. Node selects a number among 0 and 1 and check value is less than its threshold $y z/(z-1)$ power of $n (1 \bmod G)$ otherwise it gives 0. z is cluster head %. I current round and G not acted as a cluster head during past I/z rounds. To reduce the energy dissipation the CH was set to TDMA schedule for CM (Cluster member). After aggregation CH transmits it to permanent fixed station.

For whole cluster allocation time slot was used in LEACH-M. LEACH-M has drawback such as isolated cluster nodes are having more distances from the cluster heads. In randomly selecting of Cluster head causes the failure of nodes in early stages which would reduce the network lifetime. When the sensor node increases the packet loss rate also increases.

To conquer disadvantages of LEACH –M an HDMFRA (hybrid decision making algorithm with firefly routing algorithm) was anticipated. Choose a) the least distance between head and permanent fixed node b) least distance with cluster member and heads. Node CH with maximum power will be selected which would avoid the failure of nodes so it would enhance the network lifetime. In order to reduce the packet loss rate, the data aggregation and minimal data would be transfer between cluster member and cluster head. There are two types of the phase's preliminary state and stable state. Head was selected based on high energy and near to the fixed station in the preliminary state. How many number of the cluster will be needed are calculated will be calculated by the preliminary state.

In the stable phase state, maintain average power in network by data aggregation with routing firefly and re-clustering takes place when the cluster head drains.

Algorithm 1 : fire flies algorithm

```

preliminary phase started : Calculation of Head //amount of head needed
Find minimum route distance with cluster head (ch), super cluster head (sch) and Fixed station(BT)
C=Intialize the number of nodes
While (t<max dhop nodes)
for ( i=1; i=s; i++) // non cluster head
for (j=1; j=s)
identify the distance (m,n) // cluster and cluster head
move firefly i towards j // move to shortest neighbour node – best optimal way
end if
end j
end i

```

4. Simulation Results

LEACH-M and proposed algorithm HDMFRA was compared. Performances of the algorithm were evaluated using NS2.3.4 with fedora operating system . The performance metrics includes life time, energy consumption, number of non dead nodes and throughput rate. The parameters used to deploy were shown in the Table 1

Table 1. Parameter and value

Parameters	Values
Number of Sensor	2-50 in steps of 100
Antenna Type	Omni
Initial Energy	100 J
Node energy	100 J
Number of Packets	400
Listening Time	1s
Sleep time	3s
Active time	20s
Routing Protocol	Fire Fly Algorithm
Antenna Type	Omni
Channel Type	Wireless
BS Position	(75m,150m)
Propagation Model	Two way
Simulation time	200 Secs
Communication Model	Bi-directional
IFQ length	50 packets
Simulation Area	1000 * 1000 m
Queue type	Drop tail

Energy consumption with time was calculated. Higher Power consumption leads to the early fatality of the node. The proposed HDMFRA algorithm results shows the reduction of energy consumption along with high data transmission. Simulation results in Figure 2. shows the power utilization with time. Figure 3. Depicts the throughput of the data, the data loss should be calculated for efficient delivery of the data.

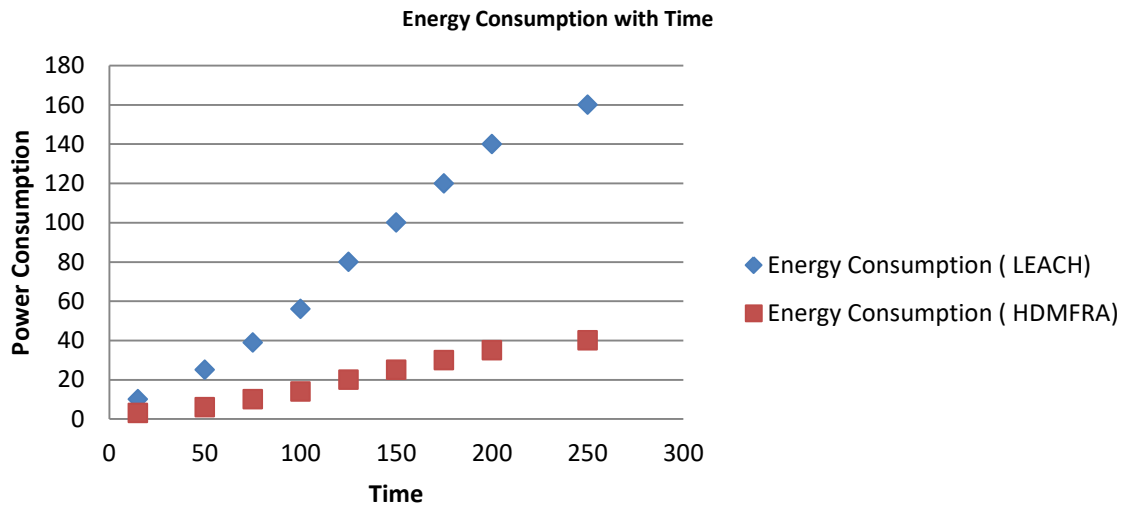


Figure 2. Power Consumption with Time

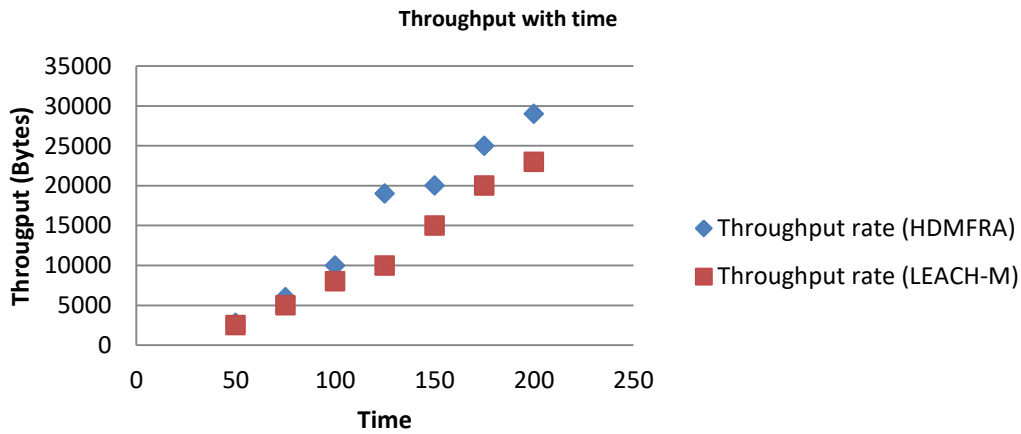


Figure 3. Throughput with Time

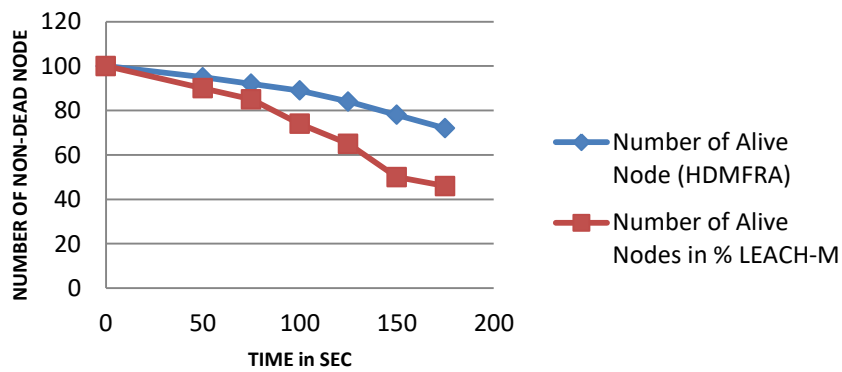


Figure 4. Number of Non-dead node with Time

Table 2. Number of Non-Dead Node

Number of Non-Dead Node % (HDMFRA)	Number of Non-Dead Nodes in % LEACH-M
100	100
95	90
92	85
89	74
84	65
78	50
72	46

Table 2 . represents the comparison of active nodes after implementation of the algorithm it shows that there was maximum number of alive node in HDMFRA when compared to LEACH- M. Figure 4 shows the alive node in the network with various time slices. Figure 2, 3 and 4 depicts HDMFRA is 25% better than LEACH –M. HDMFRA algorithm can save the power that is used by the sensor and the increases the life time of the cluster which could help the device that uses the IoT monitoring system which could be deployed with the variety of the sensors used in the different application.

5. Conclusion

Hybrid decision making algorithm with FireFly algorithm (HDMFRA) is Low power Utilizing algorithm efficient for Sensor in different IoT applications. HDMFRA uses enduring power, least distance between permanent fixed station and adjacent node cluster distances as a parameter to select head. Through the simulation results HDMFRA provide significant power saving and prolonging active mode of the sensor compared to LEACH-M protocol. An application which uses IoT monitoring system to maintain the temperature, humidity, chemical compositions was deployed by using many numbers of sensors. The life time of the sensor to be increased by using proposed algorithm through which the depletion of the energy used to transfer the data will be reduced and which would increases the life time of the sensor.

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