QOS OPTIMIZATION OF ENERGY EFFICIENT ROUTING IN IOT WIRELESS SENSOR NETWORKS

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Abstract: The internet of things is a group of connected computing, digital and mechanical machines with the capability of being identified by other devices that are internet enabled. The wireless sensor networks is a gathering of sovereign sensing elements in combination with actuating, computing, communicating and energy storing devices to keep track of the continuous physical world changes. These clique of independent sensors that commune wirelessly incurring advantages such as low cost, limited power consumption, high scalability with adaptableness to hostile and harsh environments afford them to be connected with IOT to become a part of it, to trace the physical changes encountered in the things that are internet enabled. The conventional methods for connection establishment between WSNs with IOT are more energy consuming and prone to failures in terms of network life time, packet delivery ratio and delay. So the proposed methodology that uses the concatenation of clustering with neural and simple fuzzy rule based system supported by the shortest route determination to provide with an energy efficient and enhanced routing capabilities for IOT with WSNs ensures to have a route entrenchment with reduced power consumption and improvised QOS metrics. The performance analysis is done with regard to the packet delivery ratio, energy consumption, sensor network life time and delay to evidence it perfect functioning.

Keywords: IOT-WSN, QOS metrics, Clustering, Fuzzy rule based system, Neural networks and Shortest route.

1. Introduction

The rapid progressing in the communication technologies have made possible to extend the access of internet from people to things. This technological development that has led to the new rise causing the tangible commodities to learn is the internet of things. It serves as provoke to increase the number of physical commodities that we use in our daily lives into a digital fold making the tangible objects around us into an ecosphere of information. The internet of things has bought all acts of assistance to be rendered into our doors providing a better customer service at any time,

for any one, from anywhere. It is an enabling technology that works on the inter connection of the entire physically seen things that are supported with internet on the embedded platform. So the IOT would be working with enormous number of things that are enabled with internet. The changes or the needs of the internet enabled physical world are sensed and processed with IOT and are provided with the necessary remedies. The process of gathering the information by sensing is where the sensors come into existence as a part of the IOT. The wireless sensors networks are considered to be a principle element in the construction of the internet of things paradigm as it is a promising network for capturing, actuating and communicating information regarding the needs that are entailed in the existing world. This network of   wireless sensors are constituted with the help of small sensors that are available at very low cost with very less power requirements are built with computing, energy storage and communicating equipment's. Their fully distributed nature help in having a proper communication establishment from the source to the destination for a wide area. The wireless sensors network that help out in the complete monitoring of the internet enabled interconnected network of things is connected to the internet of things either with the help of single or multiple routers or with the help of access points or the base station. Since these wireless sensor networks are battery powered the routing methodology used must be capable of providing a connectivity that has a minimized energy usage with extended network life span, and reduced delay and losses. This makes some of the conventional routing methods unsuited for the wireless sensor networks. The recent methods of routing based on clustering though seems to efficient causes excess energy usage on the deciding with the cluster head, so it becomes necessary to have an improvised routing methodology enhancing the standard of the IOT-wireless sensor networks .

The paper proposes an   enhanced and energy efficient clustering integrated with the a simple fuzzy rule based system and neural networks (FNCR), for deciding with the colleagues, head of the clusters and accompanied by routing determination extending brief paths for traversing to have an enriched network performance that is substantial with the strengthened quality of service concerning the improvisation in delay, packet delivery ratio, throughput, network lifetime and power consumption.

The paper organization follows with 2 in the related works of different types of routing available in the IOT wireless sensor networks , 3 the proposed work on the integration of the simple fuzzy and neural networks with clustering to make the routing efficient finding the shortest path ,4 the evaluation of result and comparisons with the prevailing methodologies 5 conclusion.

2. Related works

Dhumane et al [1] is using a fractional gravitational searching algorithm that is multi objective for routing establishment to have a better routing facilitated with the optimized header selection with iterative method providing a quick and safe data transmission. Yarde et al [2] gives a low energy adaptive clustering hierarchical routing

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algorithm with multi-hop to offer energy conservation during the process of communication. This algorithm used in the cross layers of MAC, physical and network layers to ensure energy consumption of nodes in the whole system. Thyagarajan et al [3] uses a quasi-mobile sink query driven model (QMSQD) for the purpose of routing in real time application of wireless sensor network to ensure an affordable cost on deployment and routing of the nodes. The computation and the maintenance of the route using the mobile sink approaches are overcome with the routing based on the QMSQD method of routing to achieve a significant energy consumption on the hot spot regions near the sink. Sarwesh et al [4] comes up with the realization of the different network architectures to have an energy efficiency and reliability in the IOT enabled using the low cost devices. Behera et al [5] uses a clustering algorithm that is more energy adaptive than the least energy adaptive clustering algorithm by rotating the cluster head based on its energy level to have a balanced energy consumption and enhanced network life time to improvise the throughput with delay incurred. Chakraborty et al [6] uses the data aggregation method that is hierarchical and transmission method that is optimized to reduce the total number transmission taking place to have an improved network life time in the wireless sensor networks used in the internet of things. Amol et al [7] the limited battery availability of the wireless sensor network are addressed using the fraction grey wolf optimizing technique that follows the ant colony optimization and the clustering techniques to have an improved battery life at the cost of network life time and overhead causing delay in the transmission. Bader et al [8] is a multiple hop cooperative clustered routing with the ability of random adjustment in the energy level to have a power efficient device with high scalability for internet of thing wireless sensor networks ensures energy efficiency with the data losses and delayed transmission. Naranjo et al [9] gives a protocol that supports a prolonged election of the cluster head to maintain the uniformity in the distribution of node, to maintain a balanced power consumption of IOT –Fog wireless sensor networks with improved network life time and overhead in the routing path Rani et al [10] is the implementation of the diminished energy consumption method to have an optimized model of internet of things with wireless sensor networks in a hierarchical approach to have flexible systems compared to the traditional methodologies. Though optimized in terms of power the model suffers from the reduced quality of service. Qiu et al [11] the emergency response internet of things with sensor nodes for real time application to have iterative method for delay optimizing with the lossless transmission shows up with an increased energy consumption and reduced network life time Al-Turjman, et al [12] it is a multi- hop routing method for disaster management in real time by employing the IOT wireless sensor networks. To achieve a higher efficiency the system is designed for using limited multiple hops with the help of left over energy may sometimes result with loss of data due the exhausted energy level.

3. Proposed Work

The proposed method causes an efficient routing to be employed which is undisturbed with the cluster grouping and election of the head that is imperfect resulting in the overburdening and latency in the transmission. So the grouping of clusters and the election methods for deciding with head takes a vital role in having a routing that is concerned with energy efficiency and QOS metrics.

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So initial stride for having an efficacious routing to mete out the energy consumption and QOS metrics, starts with the search for the sensor nodes. The sensor nodes search is to gather the information of the node with regard to the energy level it possess, its interspace to its neighboring data and access points, the strength of the data point and its mobility. The computations takes repeated repetitions for the election of the members and the head of the group of sensor network that has a significant part in deciding with the routing efficiency. The simple fuzzy rule based – neural network is used in the proposed method to provide a best choice to be put forward on electing the head and the patterning of the cluster so as to make the proposed system adept.

3.1 Patterning of Clusters

As clustering pattering and deciding on the head for clusters are important in having a perfect routing entrenchment. The head of the cluster is selected based on the search extended for the finding nodes energy level, its interspace
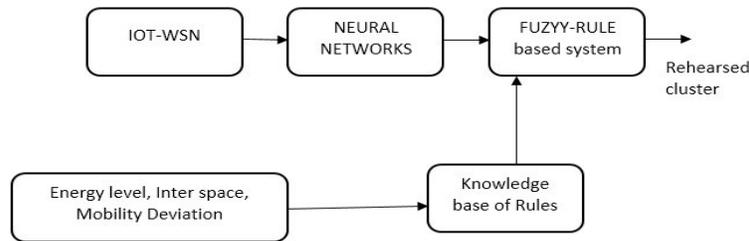

FIG 1 Proposed Method using Fuzzy

between the station and its neighboring nodes, its strength and mobility. The node with maximum energy level, with minimum traversing distance to its neighboring nodes, and medium speed deviation characteristics becomes the elected head of the clusters, the next strides proceeds with the clusters patterning, in which the membership eligibility in the cluster is decided based on the characteristics of the elected head. The required eligibility for a node to be added as member is fed into the fuzzy rule based system that is rehearsed with the preceding and the existing information's of the paradigm as shown in FIG 1. Each sensor nodes is transformed into a cluster colleagues and designated to any one of the clustering head to which ever it well suits by engaging the fuzzy rule based system, the maximum number of the colleagues to be added to the head which determines the strength of the head is limited by using the equation (1)

$$\text{HEAD}_{\text{cluster}} = \frac{M_c}{T_{sn}} < T_L \qquad (1)$$

Where M_c is the total colleagues added to the HEAD $_{cluster}$ and T_{sn} is the total available number of sensor nodes. The possibility of adding a sensor data point as a colleague to a particular head is limited Whenever the HEAD $_{cluster}$ exceeds its threshold level (T_L). Thus reducing the strain in the HEAD $_{cluster}$

```
Input Neighbor nodes
Output patterned cluster
Start
        Initialize search
        Broadcast hello message
                If (node available) then
                Begin
                Compute Energy level
                Compute Interspace
                Compute Mobility deviation
                        If (node characteristics suits the Head) then
                        Begin
                        Compute cluster head strength HEAD cluster = Mc/Tsn < TL
                        Add node
                        Else
                        Next HEAD cluster
End
        Next node
End
Stop
```
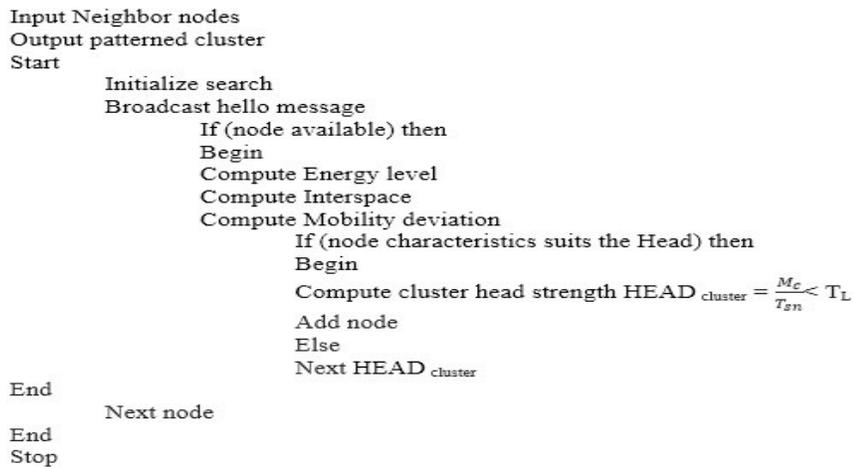
FIG 2 Cluster Patterning

The FIG 2 shows the clustering patterning of the proposed. The possible number of rules to be added to the simple fuzzy rule based system and neural network is based on the eligibility criteria set for the colleague selection. So the possible inputs to the fuzzy system is three and the possible output is one with the possible set of 3^3 rules in the knowledge base layer of the simple fuzzy rule based system- neural networks. The optimized decision on the nodes is done based on the rules set and patterned to form a perfect cluster.

3.2 The path determination with Clustering

The shortest path determination for clustering is proceeded by extending a search for the shortest path using the WFI algorithm and continuing with the transferal of the information with the neural network based system that is instructed with the channel capacity, conveyancing bottleneck and overhead that could be handled. The simple fuzzy rule based –neural network rehearses the paradigm with the rules updated and enables a routing that is efficacious. The rehearsing continues repeatedly on different time periods for the clique to have better search extended on the entrenching and continuing with the conveyance path. The route entitled starts conveying by reception of the

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information from colleagues to its head and from its head to its access points. The instructed paradigm carefully eludes the occurrence of collision and continues with its message transmission with the help of the rehearsing obtained at regular intervals. The statute controlling the operations of the route entrenchment is given using the fuzzy triangular and trapezoidal function given below in equation (2) and (3).

$$S_{F1}(A) = \begin{cases} 0 & A \le F_1 \\ \frac{A-C_1}{D_1-C_1} & C_1 \le A_1 \le D_1 \\ \frac{X_1-A}{X_1-D_1} & D_1 \le A \le X_1 \\ 0 & X_1 \le A \end{cases}$$

(2)

$$S_{F2}(A) = \begin{cases} 0 & A \le F_2 \\ \frac{A-C_1}{D_1-C_1} & C_1 \le A \le D_1 \\ \frac{D_2-A}{D_2-C_2} & C_2 \le A \le D_2 \\ 1 & D_1 \le A \le C_2 \end{cases}$$

(3)

Thus the simple fuzzy rule based system-neural network instructs the clustering to have a shortest path routing that is optimized to providing a higher performance quality.

The Simple fuzzy rule based –neural network system is rehearsed with the optimized choices of energy level, speed of mobility deviation, and the interspace requirements for having efficient cluster formation with the maximum number of colleagues in a cluster being restricted according to the equation (1). Further applying the rules of fuzzy-neural networks ensures in having an efficient path entrenchment that is aware of channel capacity, conveyancing bottleneck and overhead with negligible amount of delay and failures in the path, network life time and packet deliveries ensures in providing the proper choices using the equation (2) and (3). The energy exhaustion of the elected head results with the repeating the process of the election to have a colleague with the optimized characteristics to be the elected head, for the routing to be carried out in a well-organized manner. Thus the path entrenching based on the clustering supported by the simple fuzzy rule- neural network system turns out to be an efficacious method for having energy efficient routing and rerouting with improved QOS metrics.

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4. Result Analysis

The proposed method of simple fuzzy rule based-neural network is simulated and evaluated on the network simulator-2, and compared with the prevailing technologies to prove the efficiency of the proposed method. The evaluation is done with different number of sensor nodes that are connected wireless ranging from ten to two hundred being randomly distributed in the area of 1000 meters and the area of transmission being extended to a five hundred meters with the initial energy of 100joules. The packet are at the size of 1024 bits and one packet is transmitted per second. The evaluation is done based on the QOS metrics to determine the efficiency of the path determination of the proposed.

a) Throughput

The throughput enables in determining the perfect functioning of the device by measuring the successful transmission taken place at regular intervals. The success in the conveyance shows that the route entrenched is maintained without any sudden failure and losses. The proposed methods ensures in having a heightened throughput rehearsing the clique for a proper route maintaining by the rule based system of fuzzy and neural networks.

The throughput evaluation in the FIG 3 shows the performance of the proposed method under variations in the availability of nodes at regular period of intervals shows the supreme performance of the proposed and its heightened throughput compared to the prevailing methods of routing.
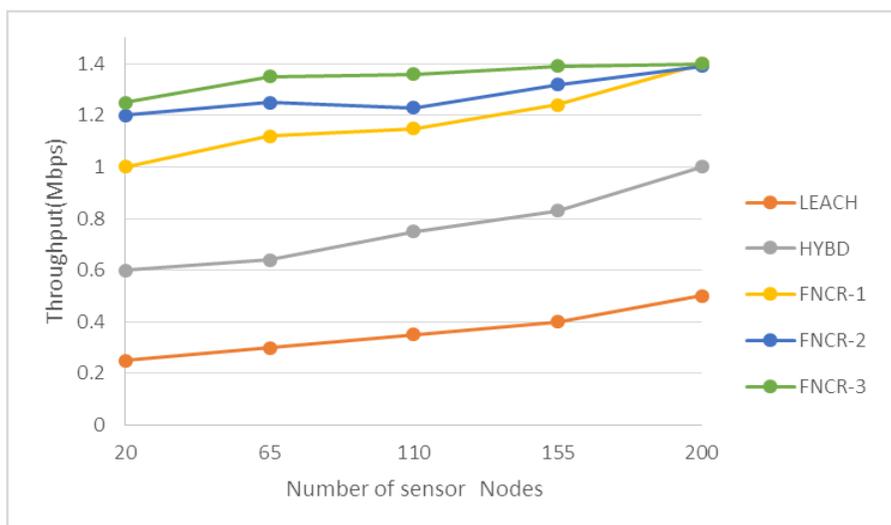
FIG 3 Throughput

b) Power consumption

The power consumption of the proposed method is perceived by summing the product of the transmitted energy and the available nodes with the energy requirement at the reception. The power calculation at different conditions with variations in the number of available nodes shows the limited power consumption of the 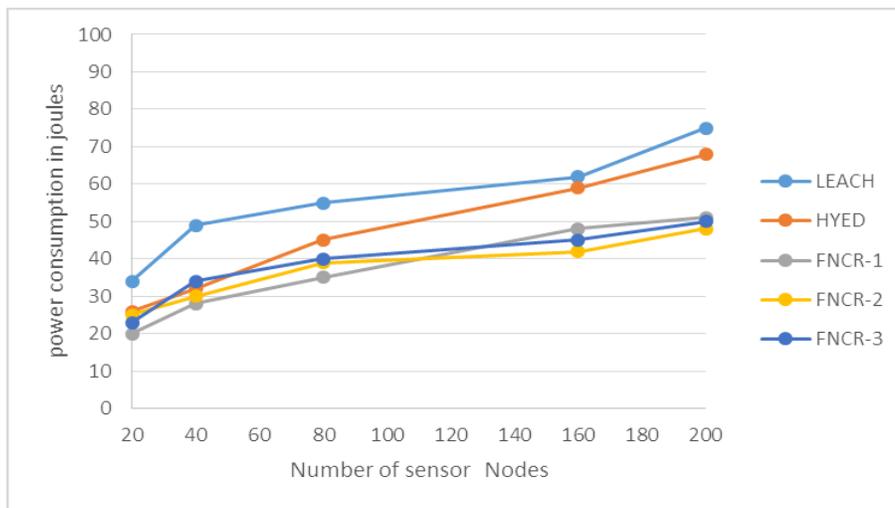proposed compared to the prevailing   systems.

FIG 4 power consumption

The power consumption graph in the FIG 4 gives the improvisation achieved in the power consumption for the proposed system compared to the high power utilization of the prevailing methods of routing that are not trained with the simple rule based fuzzy-neural networks

c) Life span of the network

The life span of the network is determined using the available alive nodes in the network. The battery powered wireless sensor nodes are utilized in a well-organized manner by the proper election of the head in the cluster and perfect patterning thereby eluding the unwanted usage of the energy of these sensor nodes and extending the life span of the system.
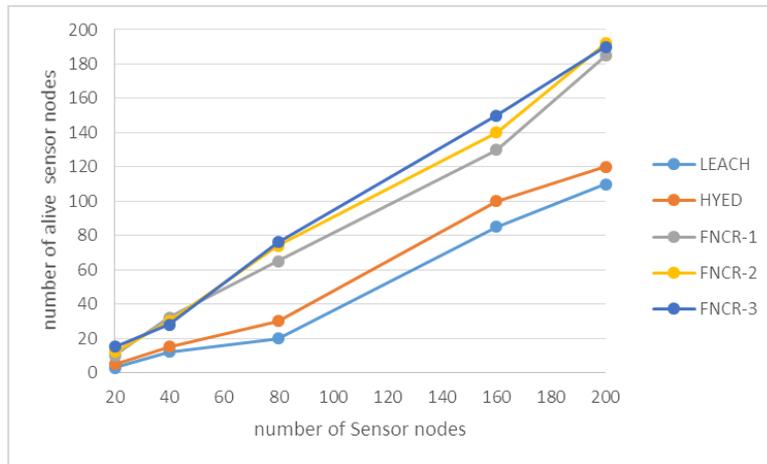

FIG 5 Life span of the network

The graph of the network life time in FIG 5 show the enhanced life time of the proposed clique as the energy wastage on electing the head and cluster patterning is limited due to the proposed method based on the simple fuzzy-neural rule based system that helps in the perfect route entrenchment and maintaining under different computations with different number of nodes and the comparison performed shows that the proposed FNCR is a an optimized way of routing than the preexisting methods.

d) PDR in %

The packet delivery ratio gives the gross amount of the total successful deliveries of the packet compared to the number that was transmitted. The performance evaluation on the grounds of packet delivery ratio on diverse conditions given in the FIG 6 shows the capability of the proposed system to entitle maximum number of transmissions compared to the present methods.
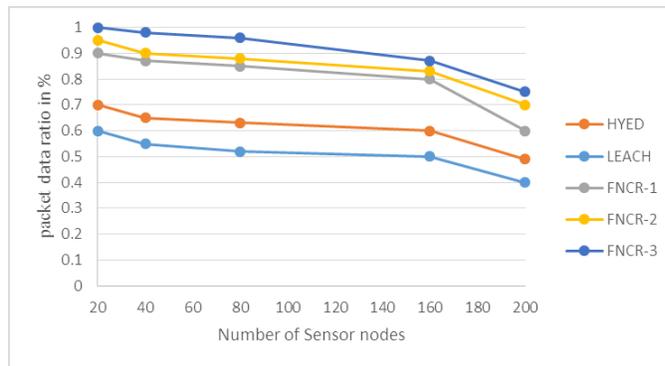
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FIG 6 Packet Delivery Ratio

e) Delay

The network is subjected to a certain amount of delay during the transmission. This delay which is measured as the time difference between the transmission and reception is the total time taken by the network for conveying the information from the source to the destination. Usually the delay incurred by the network increases only when there are sudden damages in the established route and when more time is taken for the rerouting process. The proposed system that is rehearsed with the capabilities for proper route maintenance ensure the delay attained by the system would be very low compared to the preceding methods for cluster based routing.
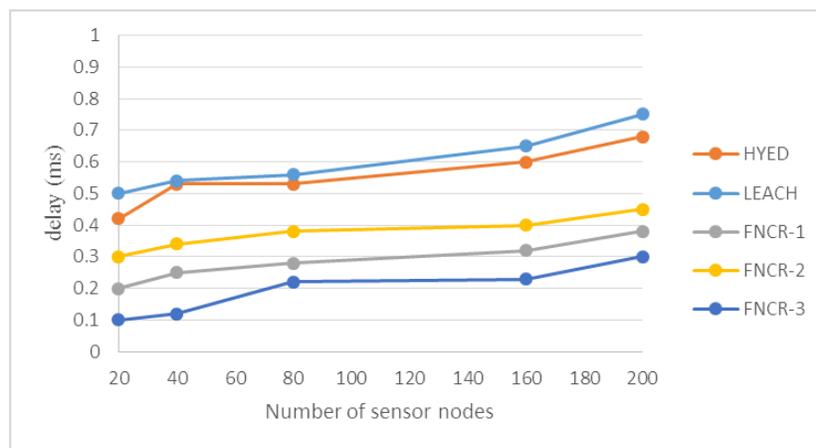
FIG 7 Delay

The curve for delay calculation in the FIG 7 shows improvised delay characteristics of the proposed compared to the previous methods that are available for the purpose of the route finding. Thus the proposed method performance on evaluating and comparing proves to be an enriched method of routing when concerned with power consumptions, delay, network life span, throughput and packet delivery ratio.

5. Conclusion

The wireless sensor networks as a part of internet of things turns out to be well engineered only on the perfect connection between the Sensors and the internet of things. The gateway that enables the connection establishment is properly designed in the proposed method using the simple fuzzy rule based-neural networks clubbed with the clustering to have a proper exploitation of energy evading the wastage caused during the selection of the head and the patterning of the cluster. The repeated computation based on the rehearsed set of information's ensure a proper path formation that is stable throughout the transmission. The rehearsed system enables the cluster patterning and the routing to make optimized choices on the selection of the nodes for conveying and affords a delay less, energy aware and less failure proposed system for transmission. The performance evaluation of the proposed compared to the preceding methods prove that the proposed system is highly adept.

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