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Energy Efficient Routing Algorithm for WSN-IoT Network

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ABSTRACT

In various domains, to enable reaction and detection of anomalies IoT (Internet of Things) have infrastructure in which significant sensory data gathering method is important because IoT nodes has limited computational capacity and energy. Range rather than sensory data accurate value which is fascinating to domain applications, range is expressed as sensory data category. Redundancy of data is discouraged by the routing algorithm and current data transfer, which decreases energy, bandwidth and memory usage. Between energy consumption and security level, there is tradeoff. Security level is nothing but it is intensive computational operations. For Secure transmission of data and to minimize consumption of energy in IoT-WSN networks, this paper proposes Spanning Tree Based Flooding Mechanism with Cooperative Game Theory (STBFM-CGT) method for efficient data transmission. To minimize consumption of energy in IoT-WSN networks, this paper proposes Spanning Tree Based Flooding Mechanism with Cooperative Game Theory (STBFM-CGT) method for efficient data transmission. For synchronization purpose, sensory data of IoT is routed and predicted through data prediction model in cloud. When compared with state-of- art method by considering packet delivery ratio (PDR), network lifetime, throughput and energy consumption, this method achieves better results. As a result, proposed method achieves 23.8% energy consumption, 53.2% network lifetime, 75.4% of PDR and 76.6% of throughput.

1. INTRODUCTION

In recent years, IoT is fast developing and promising research area to support different types of domain applications i.e ITS (Intelligent Transportation Systems) for traffic flow monitoring in which to support anomaly detection and environmental monitoring in industrial applications, continuous sensory data is important [1]. For source determination and anomaly detection, like WSN sink node, IoT networks smart things which is WSN sensor nodes are significant to sense environment variables as well as gather and route sensory data packets to center.

The Internet of Things allows businesses to streamline operations and save money on manpower. Furthermore, it provides visibility into business transactions, reduces manufacturing and delivery costs, and enhances service quality. Monitoring system, home automation, and the detection of chemical and biological attacks are only some of the control systems that make use of IoT and WSN. Data collected by WSN devices is processed and transmitted to off-site locations using IoT devices and applications.

Considering truth that dominant part of observing time may mirror a sound circumstance for most applications and a moderately high energy utilization of sensor nodes for sending tangible data bundles along directing ways, a decrease in measure of tactile information to be sent over organization is important to draw out presence of WSN, where sensor nodes are regularly confined inside network [2]. Supplied energy and processing capacity are limited resources of IoT [3]. Without direct power consumption, when an IoT required used in environment, it requires batteries for its operation. In wildlife protected areas and agricultural field, IoT node battery replacement is sometime impossible or it is difficult. As IoT and WSN nodes purely rely on battery, energy management is a challenging task, however traditonal models energy consumption is high and the routing process also consumes more power due to the node validations that degares the network performance. In order to overcome the limitations of traditional models, an efficient energy consumption reduciton routing algorithm is required to enhance the WSN performance.

Most research carried out on how to minimize battery [4] usage on WSN as a battery-restricted sensing technology to solve this issue, and many methods have been developed to effectively increase battery use [5]. To develop various IoT platforms, WSN is used as a part of IoT technology. Various routing strategies, such as opportunistic routing [6] as well as selfish methods [7], increase power efficiency on sensor networks. On sensor networks, clustering technique was developed to reduce power consumption in sensor and increases network's longevity [8]. This paper proposes data transmission method to stabilize data routing in IoT nodes which gives networks good consumption of energy.

In comparison with other wireless networks types, game theory is considered as preferable method. WSNs solutions are fully or partially distributed. In terms of other hardware resources and battery life, WSNs nodes are fixed, homogenous and resource constrained. In order to increase network lifetime and providing required QoS [9], Nodes have competing energy saving priorities. For each specific issue, researchers have some provocation in choosing applicable game model as well as defining utility function [10].

The network lifetime, energy consumption parameters are evelauted in the porposed model and the route efficiency is also considered for calculating the proposed model performance levels. The results when contrasted to proposed model, exhibit better performance levels. The most important contributions of the proposed STBFM-CGT is shown in Table 1.

Table 1. Most important contributions of the proposed STBFM-CGT

S.No	Contributions	Explanations
1	Data Routing in IoT Nodes	Here the networks are provided with decreased energy consumption to stabilize the data routing in IoT nodes. The efficient path in the network is selected by the mentioned approaches for the efficient data communication among different devices within the network.
2	Cluster Head (CH) selection dependent on spanning tree based flooding mechanism	First the cluster head is selected and next the data is transmitted using spanning tree based flooding mechanism. The graph is also constructed and minimum distance is found under flooding pressure. Cooperative game theory procedure is applied to make the data transmission efficient. The target of minimum distance and efficient data transmission is achieved here.
3	Life time of Network	A new technique i,e combination of spanning tree flooding and game theory approach is used to lowered the energy consumption, throughout the network and improves efficiency of network.
4	Validation	The simulation results are calculated based on energy consumption, network lifetime, PDR and throughput. The performance analysis is compared for STBFM-CGT with ANFIS - PEGASIS and 3L-HEXA-HTBTDP.This method achieves better results than the previous approaches.

To meet high energy demands of wireless systems, this protocol is beneficial in web of things and cellular communication applications. Scalability is carried out on different numbers of sensor nodes with initial energy values to perceive discrepancies. In most of the existing method there is inefficiencies in data transmission and delay. By using the cooperative game theory method with the combination of spanning tree flooding method, the limitation of data transmission inefficiencies, delay is rectified. The proposed method will offer social IoT network system security experts the ability to transfer the data more effectively. The method can also act as a reference for constructing a safer social WSN IoT network system.

This model includes confidence that within a reasonable time method converges to desired solution. This paper organization is as follows, section 2 gives literature review, section 3 discuses research methodology, section 4 gives result followed by conclusion in section 5.

2. RELATED WORK

Kumar et al. [11] developed ANFIS-PEGASIS in WSN using IoT. For optimum Cluster Head (CH) is used in FIS (Fuzzy Inference System) process which is based on residual energy and distance. For data collection within irrigation framework, PEGASIS (Power Efficient Gathering in Sensor Information System) is used. PEGASIS makes chain between SNs as well as every node communicates with CH and transfers data to BS (Base Station). For automated irrigation process, by using ANFIS (Adaptive Neuro FIS) decision making process is executed. Limitation is that it has data transmission delay as well as lack in energy efficiency.

Al-Qurabat et al. [12] proposed a model for PSNs lifetime optimization in IoT applications, DGAST (Data Gathering and Aggregation with Selective Transmission) was proposed. To extend sensors battery lifetime, it gathers sensor data periodically. It also gives protocol to divide PSN lifetime into rounds. It consists of 4 phases. They are data aggregation, data gathering, adjusting samples frequency and selective transmission for every node in dynamic climate change context of sensed environment. To satisfy need of application, reconstructed data quality is poor and it is not fully identified all spatial and temporal correlations in and between nodes.

Maheshwari et al. [13] researched the distribution of reserved slots to mobile nodes in the existing TDMA schedule in the latest CH vicinity. Method of assigning allocated slots to mobile nodes as a cooperative game. In order to facilitate collaboration between mobile SNs, author suggests a cooperative communication method for access to reserved slots in order to avoid unwanted loss of packets and network delays. Drawback is that WSN has a high mobility rate and number of slots to prevent collisions is expanded, providing more memory requirements.

Kumar et al. [14] developed MDF (Multisensor Data Fusion) method which execute fusion of collected network specifications such as selection centrality and bandwidth in selected path. On sensed data which is lost, data aggregation is performed. This problem is solved by a process of data fusion called MDF method. For choosing suitable path for sensed data forwarding, this method performs network link parameters fusion. In terms of different performance metrics, IoT oriented WSN performance is evaluated by using MDF methods. For path selection and with data aggregation methods, it determines network parameter fusion. Main disadvantage is that it has high packet drop rate.

Shrivastav et al. [15] developed a model for increasing networks energy efficiency, Three Level HEXAGONAL Heterogeneous Broad Transmission Distance Protocol (3L-HEXA-HTBTDP) was proposed. Advanced, super advanced, and normal sensor nodes define 3 degrees of heterogeneity in the hexagonal area. Based on new thresholds, these nodes are selected as CHs and transfers collected data to BS. To meet high energy demands of wireless systems, this protocol is beneficial in web of things and cellular communication applications. Scalability is carried out on different numbers of sensor nodes with initial energy values to perceive discrepancies using proposed procedure.

Hsu et al. [16] designed an efficient method for smart home system using IoT-WSN, MSDF was proposed. To propose smart home system, author combined sensor fusion technology and wearable intelligent technology with AI. To recognize and identify different dimension gestures, wearable technology is utilized. Due to the management of smart energy used by machines, AI was chosen by computer. To realize home safety for alarm method and intelligent fire detection, MSDF is utilized. Drawback of this system it has more energy consumption during sensor fusion process.

Jabbar et al. [17] designed a model for Mobile Adhoc Networks-Wireless Sensor Networks, a hybrid Multipath Energy and Quality of Service (QoS)-Aware Integrated Link State Routing Protocol version 2 (MEQSA-OLSRv2) was created to address issues of scarce energy power, node mobility, and traffic congestion during data transmission in IoT network convergence scenarios (MANET-WSN). A node rank based on Multi Criteria Node Rank (MCNR) is used for this protocol. This MCNR incorporates multiple energy as well as QoS parameters into a systematic metric to significantly minimize uncertainty of multiple restricted considerations and prevent overhead control induced by multiple parameters being broadcast separately.

Izaddost et al. [18] analyzed efficient energy transmission in IoT environment. It considers the responsibility notwithstanding the accessible power level to choose the sending hub. The analysis shows next sending hub will work for a more extended time frame even it has a lower power level contrasted with the other hubs. It builds network soundness and diminishing the quantity of lost bundles during the information transmission.

Jamin et al. [19] developed a model for routing in wireless sensor networks, created a non-cooperative, dynamic, and comprehensive game model. The goal for each player in the game is to restrict the amount of energy used and the time it takes to steer towards the sink hubs. The participants choose their strategies on their own to improve the energy delay in routing by using the best routing path based on SINR values.

Tarek et al. [20] proposed a wireless sensor networks, the most recent game theory strategy is used to gain the trade-off of maximum network lifetime while providing the required service. It contains a complete scientific categorization of games as they relate to the topic at hand.

Chandnani and Khairnar [21] presented the improved Modified Power-Efficient Gathering (Aggregation) in Sensor Information System (Modified-PEGASIS) algorithm. It is used for efficient data accumulation and routing in IoT Wireless sensor networks. It gains maximum data safety, higher throughput, packet delivery ratio, end to end delay, routing overhead, energy consumption and security.

Kumar et al. [22] show packet delivery scheme for industrial IoT in wireless sensor networks. Instead of IEEE 802.15.4, the G.9959 convention was chosen, and the IPv6 delivery packet rate was compared in terms of energy and latency. Aside from that, an analysis is carried out to determine the impact on energy when transmission capacity is reduced. When compared to other schemes, it performs better.

Baldesi et al. [23] determine the original hypothetical structure for better allocation of resources to flood information in mesh networks with low obligation cycling without the need to fabricate a distribution tree or some other conveyance overlay. This technique just necessitates nearby computations based on each hub area. This study was generated using calculations of the eigenvector centrality of hubs in a network graph using old style dynamic dissemination models on graphs.

Chelik and Beghdad [24] aim to introduce a half breed approach joining both receiver-receiver and sender-receiver plans to lessen the variety of two-way message trade spans, in substantial burden organizations. To achieve network-wide synchronization, a modified Prim's computation is used to construct a traversal tree, ensuring the minimum number of predecessors and limiting the spread of errors. It competes with a number of the most widely used synchronization protocols. It's ideal for WSNs, especially if MAC layer time stamping is a pain. In large distant sensor network setups, it can also be used to achieve time synchronization in single leap and multi hop networks without the use of MAC layer time stamping.

Vaiyapuri et al. [25] presented an IoT enabled cluster based routing (CBR) protocol for information centric wireless sensor networks (ICWSN), named CBR-ICWSN. This model undergoes a black widow optimization (BWO) based clustering technique to select the optimal set of cluster heads (CHs) effectively. CBR-ICWSN technique involves an oppositional artificial bee colony (OABC) based routing process for optimal selection of paths. A series of simulations take place to verify the performance of the CBR-ICWSN technique and the results are examined under several aspects. The experimental outcome of the CBR-ICWSN technique has outperformed the compared methods in terms of network lifetime and energy efficiency.

Li et al. [26] presented Differentiated Threshold Configuring Joint Optimal Relay Selection based Data Aggregation (DTC-ORS-DA) scheme. A priority-based relay selection algorithm, which enables child nodes to dynamically select the parent node with the highest priority based on the number of data packets, waiting time, and remaining energy. The performance comparison with Common data collection Scheme (CS) proved that, the DTC-ORS-DA scheme reduces the average delay by 10.74%-19.91%, increases the life cycle by 9.81% at most, and the energy utilization rate is increased by 6.67%-9.48%.

In the aforementioned methods, there occurs many problems in the consumption of energy in the process of fusion, drop of packets, collision expansion and poor data transmission. To overcome this limitation, cooperative game theory method with the combination of spanning tree flooding method is proposed. If the energy consumption is decreased, the lifetime of the network will be improved, then the performance of the system is improved automatically.

Transporting information from the sensor nodes to the base station necessitates the use of routing methods. There are a number of distinguishing features that set WSN routing apart from IP network routing, including the fact that it would be impractical to construct a global communication protocol for a sensors nodes and the fact that, in contrast to conventional correspondence systems, nodes in a WSN network are not directly connected to one another. Every application of sensors necessitates a constant flow of detected data from a wide variety of sources. Sensor nodes are dispersed around an area to collect data and relay it to the appropriate parties. We need a scalable and efficient routing protocol that can choose the best paths in between sensor nodes and the typically far-flung users in order to do this. Because of the need for environmental embedding, sensor nodes are often very small, with limited processing and memory, and small battery sizes. An essential feature of wireless sensor routing protocols is low power consumption, which helps to extend the useful life of the network and individual wireless sensor nodes.

3. PROPOSED METHODOLOGY

By implementing the proposed process, effective data transmission in WSN-IOT is achieved. Figure 1 illustrates architecture of proposed method.

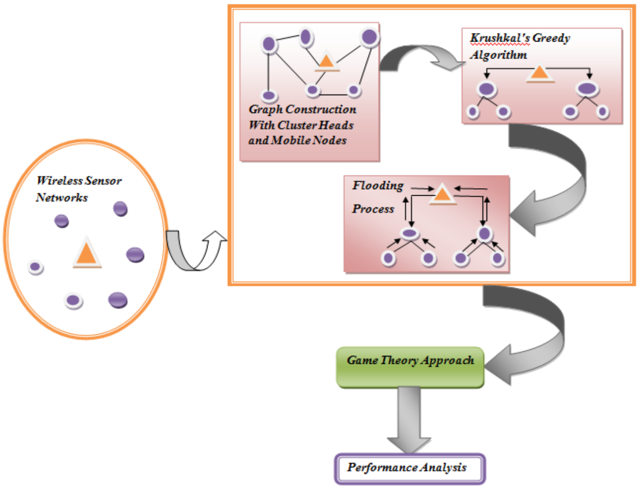

Figure 1. Architecture of proposed method

In this proposed method, cluster head selected first and data transmission using spanning tree based flooding mechanism was constructed, in which the graph is constructed and minimum distance is found under flooding pressure, Cooperative game theory procedure is applied to make the data transmission efficient. By using this combination of spanning tree flooding and game theory the energy consumption is lowered and therefore lifetime of the network is improved.

Two rounds, i.e., collection of CH and creation of clusters, perform clustering behavior. WSN protection can be improved by a secure CH selection process. If a node wishes to be a CH in the first round, it can submit a message to its single-hop neighbors. Then, based on previous node actions, the neighbors react. If number of supporting responses reaches a certain threshold value, node is called a CH node. Remaining nodes are automatically formed after selection of the CH node in the second round partnership with CH. Finally, residual nodes serve as Mobile Nodes (MNs) of CH nodes and clusters are created.

3.1 Data transmission using Spanning Tree Based Flooding Mechanism (STBFM)

Spanning tree with a balanced structure is built for routing purposes, while BS functions as a root node and CH nodes have same child number. After receiving data packets from child nodes, each intermediate node can combine data packets with its own sensed data. Let us consider that all nodes have a set compression ratio and generate constant-size data packets. Send data packets to parent and root nodes. Root node is also known as a sensor node, which communicates through single-hop communication with sink node. This network is referred to as graph G (V, F), where V = {v1,..., vn} is a set of vertices representing sensor nodes and F is a set of contact links between sensor nodes.

$$F = \{f_{xy}\} x, y = 1,2,3, \dots . n \tag{1}$$

where, F_{xy} shows the expense of connectivity between x and y vertices.

From graph G, construct spanning tree. First cluster nodes in network S into S(1), S(2), .., S(n). By utilizing method called Kruskal's greedy algorithm, each subset (cluster) discovers the best possible expansion of a spanning tree or maximum forest on its own vertices. It constructs the spanning tree here by considering a tree's nodes as an ascending order of its weight by finding shortest path between two nodes in cluster. Similarly, beginning with initiator node MST, less weight path (edge) is selected to attain sink node, and less weight edge is selected to create spanning tree. Each node calls STBFM Flood algorithm upon receiving a broadcast message. If message has been used before algorithm decides. If not broadcast set (BSET) is determined by providing one hop topology data to MST. BSET eliminates previous transmitting node and any adjacent nodes that could have heard previous transmission. If BSET is not an empty set, transmitting power needed to enter remaining BSET nodes is calculated and message is retransmitted.

3.2 Cooperative game theory approach

Game theory approach is chosen to find an energy as well as delay-aware route, when nodes attempt to play cooperative games as well as try to optimize their own advantages by selecting least energy as well as delay required propagation path to sink node. Game begins at root of tree, where a pass is made by first player, and finishes at leaf. Each player has a payoff at each stage that contributes to utility function generation. Decision nodes are called non-leaf nodes. Potential moves of a player are allocated to outbound edges of decision node. They are separated into data sets. When player makes a move then he only knows data set in that no other player knows. Under Nash Equilibrium, every stage net utility of decision stage is computed as well as leaf node is attained. [N, A, H, Z, X, p, cr, u] is called game, where N indicates two players set n1 and n2. Possible actions set are nothing but it is transmission power level as well as N_e. Possible actions is defined as cross product of two sets P {P_1, P_2} and N_e {$n_{1,2}$ sink}.players possible action is given by cross product of two sets. In tree where players make a decision, H is a group of non-terminal choice nodes. Action function: X: H->2^A assigns a set of possible actions to every node's choice. Function Player p: H N assigns a player I to each terminal node h. E: N selects action at h. Disjoint from H, set of terminal nodes is a Terminal nodes Z.

Set of possible next node and power levels are two sets of players data set. For both players, possible power level set is same. Let us consider two possible power levels P_1 and P_2. n_1 is first set {n_2 Sink} and n_2 is {n_1 Sink}. Consider both sink and nodes are neighbors of each other. In extensive game, utility function is utilized.

$$U_{net}(S_i,S_{-i}) = \frac{LR}{MPi} + f(y_i) - \left(\frac{Ered}{Eref} + \frac{delay}{Dref}\right) \tag{2}$$

where, using strategy S_i, L is data bits at a rate R bit/s, P_i is transmission power level.

$$Efficiency\ function\ f(yi) = (1 - 2Pe)M \tag{3}$$

where,

P_e is BER (bit error rate).
E_{ref} is energy reference and
E_{red} is energy reduced for selected strategy.

D_{ref} is delay reference.

Y_i is a SINR quantitative measure of i^{th} node estimated.

Player 1 makes first move as well as picks next one. It has two n_2 and sink options for forwarding data. Action is taken in next stage player 2. Land Player 2 takes action again and consecutively picks power levels. 16 possible outcomes exist. When all nodes finish forwarding data, game ends. It's possible to stretch game until all data hits sink. Nodes utility is given by sets (V_I, V_2, ..., V_{I6}).

Algorithm 1. Spanning Tree Flooding Mechanism with Cooperative Game Theory Method

Initialization: source node= *s*, destination node=*l*; set learned cost *h*(*s*, *l*), estimate cost *c*(*s*, *l*); set query command *Q*, next hop *H*;

Step-1 Cluster Head (CH) selection

Round1←N_1

Round2←N_2

Roundn←N_n

N_n← threshold

Step-2 Graph formation and flooding

G (V, F) and F = { f_{xy}}

STBFMFlood(message)

Step-3 If not seen message before

BSET = MST (1-hop neighbours)

Last (Q)= last node to broadcast

Listen= find neighbours (i^{th}) that receives the prior broadcast message

H = i^{th} neighbour;

s transmits *Q* to *H*;

end if

BSET= BSET-Last

BSET= BSET-Listen

If BSET≠0

If *s* knows learned cost of *H* then

$$h(s,l) = h(H,l) + h(s,H)$$

else

$$h(s,l) = h(H,l) + c(s,h)$$

end if

iteration among residual nodes until *H* is *l*

Step-4 T(energy)= max energy (BSET)

Broadcast (message, T(energy))

4. PERFORMANCE ANALYSIS

Comparison of proposed STBFM-CGT method is done with existing methods such as, 3L-HEXA-HTBTDP and ANFIS -PEGASIS by considering different parameters like Throughput, Energy consumption, Network lifetime, PDR. Simulation is executed using ns2. Table 2 represents simulation parameters.

- **Energy consumption:** It is measured as total energy of all hops.

$$\text{Energy} = \frac{1}{p}\sum_{n}^{p} E_n \quad (4)$$

where, p denotes hops in multi-hop routing and E_n is energy of n^{th} hop.

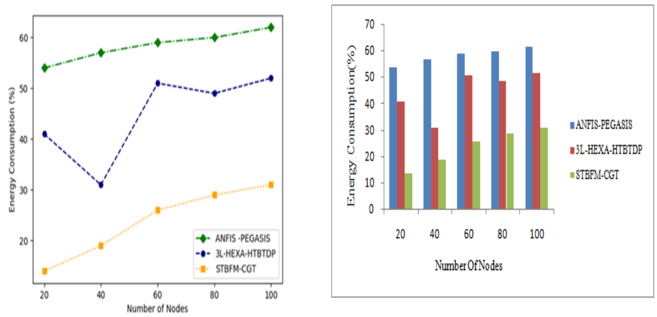

Figure 2. Comparison of Energy Consumption in ANFIS-PEGASIS,3L-HEXA-HTBTDP and STBFM-CGT

- **Network lifetime:** It is defined as node lifetime which is taken as maximum to achieve effective routing.

$$Network\ Lifetime = \frac{1}{p} \times \sum_{n=1}^{p-1} \frac{M(N_n, N_{n+1})}{\beta} \quad (5)$$

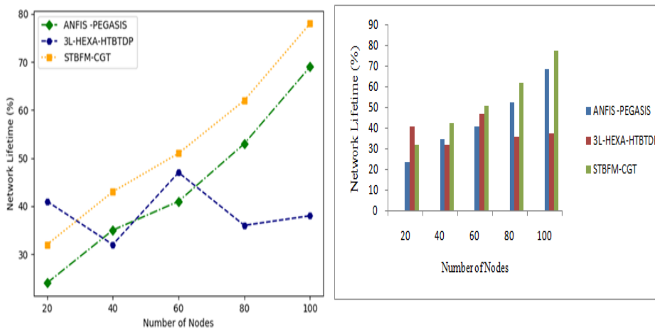

Figure 3. Comparison of Network Lifetime in ANFIS-PEGASIS,3L-HEXA-HTBTDP and STBFM-CGT

- **PDR:** It is defined as ratio of no. of received packets to total no. of forwarded packets.

$$\text{PDR} = \frac{\text{Number of packet received succesfully}}{\text{Total number of packets forwarded}} \quad (6)$$

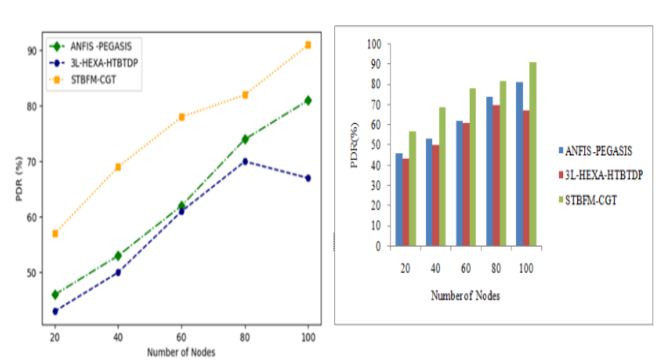

Figure 4. Comparison of PDR in ANFIS-PEGASIS,3L-HEXA-HTBTDP and STBFM-CGT

- **Throughput:** In a communication channel, it is defined as data flow rate. It is an essential measurement while monitoring continuous streaming data in IoT-WSN environment.

$$\text{Throughput} = \sum \frac{(\text{number of successful packets}) * (\text{average packet size})}{\text{Total Time sent in delivering that amount of data}} \quad (7)$$

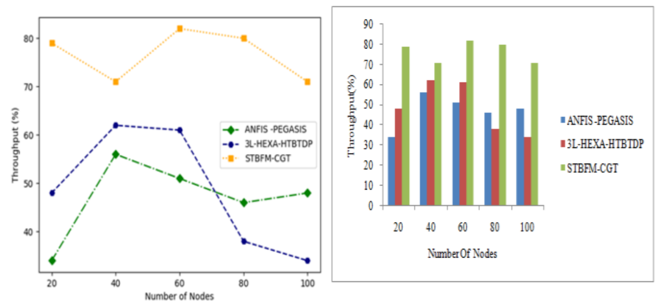

Figure 5. Comparison of Throughput in ANFIS-PEGASIS, 3L-HEXA-HTBTDP and STBFM-CGT

The above Figures 2-5 show energy consumption, network lifetime, PDR, throughput of existing and proposed methods. X and Y axis represent number of nodes and parameter metrics in % respectively. It is inferred that the proposed method STBFM-CGT in 100 node consumes nearly 21% and 31% of lower energy, achieves greater lifetime nearly 40% and 9%, achieves greater PDR nearly 24% and 10% and greater throughput nearly 37% and 23% than 3L-HEXA-HTBTDP and ANFIS –PEGASIS respectively.

The following table represents performance analysis of Energy consumption, Network lifetime, PDR, Throughput of both proposed and existing methods.

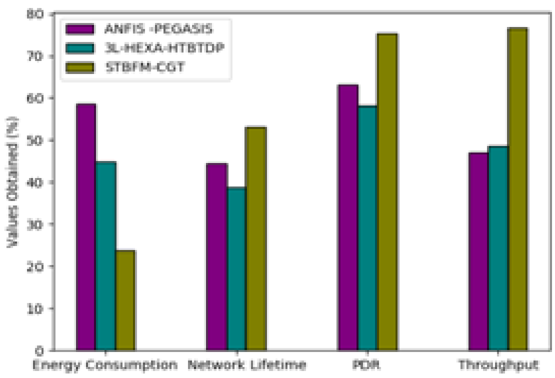

Figure 6. Overall Comparison

Table 2. Assumptions of Simulation parameters used

Simulation Parameters	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Network type	2-D Field	2-D Field	2-D Field	2-D Field	2-D Field
Location of base station	Center (0,0)	Center (0,0)	Center (0,0)	Center (0,0)	Center (0,0)
Total nodes (N)	20	40	60	80	100
Area (m)	40 X 40	80 X 80	120 X 120	160 X 160	200 X 200
Data Packet Size	500	500	500	500	500
No of cluster heads	3	5	8	10	13
Initial Energy of nodes	0.7J	0.7J	0.7J	0.7J	0.7J
Simulation Time(s)	100	200	300	400	500

Figure 6 indicates overall comparison of existing and proposed methods. X and Y axis implies various parameters and values obtained in % respectively. As a result, proposed method achieves 23.8% energy consumption, 53.2% network lifetime, 75.4% of PDR and 76.6% of throughput. The Comparison of parameter metric values calculated by ANFIS-PEGASIS,3L - HEXA - HTBTDP, STBFM-CGT is shown in Table 3 and overall performance analysis is shown in Table 4.

Table 3. Comparison of parameter metric values calculated by ANFIS-PEGASIS, 3L-HEXA-HTBTDP, STBFM-CGT

No. of Nodes		Existing ANFIS - PEGASIS (%)	Existing 3L-HEXA-HTBTDP (%)	Proposed STBFM-CGT
ENERGY CONSUMPTION(J)	20	54	41	14
	40	57	31	19
	60	59	51	26
	80	60	49	29
	100	62	52	31
NETWORK LIFETIME (in units of time)	20	24	41	32
	40	35	32	43
	60	41	47	51
	80	53	36	62
	100	69	38	78
PACKET DELIVERY RATIO (%)	20	46	43	57
	40	53	50	69
	60	62	61	78
	80	74	70	82
	100	81	67	91
THROUGHPUT (Bytes per second)	20	34	48	79
	40	56	62	71
	60	51	61	82
	80	46	38	80
	100	48	34	71

Table 4. Overall performance analysis

Parameters	Existing ANFIS - PEGASIS (%)	Existing 3L-HEXA-HTBTDP (%)	Proposed STBFM-CGT
Energy consumption(J)	58.5	44.8	23.8
Network lifetime	44.4	38.8	53.2
Packet delivery ratio	63.2	58.2	75.4
Throughput	47	48.6	76.6

5. CONCLUSION

Ad hoc networks of wireless sensor nodes can be placed on a battlefield and allowed to self-organize. The fact that a node has a finite amount of energy is not taken into account by standard routing protocols. Optimal routing entails looking into the future so that it can optimise the amount of time that the sensing task can be carried out. This paper proposes STBFM-CGT(Spanning Tree Based Flooding Mechanism with Cooperative Game Theory) method for efficient data transmission with minimized energy consumption which used cooperative game theory model for optimal routing process and hence the packets are transfer towards IoT platform gateway server. Network Stability is improved by applying the proposed method. Proposed method has less packet loss so that gateway server received packets amount increased. As a result, it is found that the proposed method achieves 23.8% energy consumption, 53.2% network lifetime, 75.4% of PDR and 76.6% of throughput. Data integrity and security in an IoT setting will require further work to establish a probabilistic strategy using meta-heuristics. With the purpose of minimising the impact of mobility and topology changes under these severe power constraints, novel routing strategies are necessary. Additional potential future study for routing protocols is bridging wireless sensor networks (WSN) with wired networks such as the Internet.

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