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A Novel Hybrid Energy Efficient Model using Clustering in Wireless Sensor Networks

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ABSTRACT- An innovative hybrid approach is presented in this paper aimed at rapid predicting the optimum routing path selection in WSNs using the Lagrangian method and Clustering. The main motive of this work proposed is to maximize the clustering productivity, reduce the congestion in routing system and optimize the energy range in the network. By combining the route prediction through clustering and energy flow estimates in the routing protocol design-based algorithm, this will combine both the objectives of rapid route prediction and energy flow estimation. A Distributional Heterogeneous Pathfinder (DHP) based routing algorithm was used in this optimal clustering system to predict the best routing paths in the network and to optimize network energy consumption. In general, sensor communication in the Internet of Things takes place with tremendous amounts of data transmission and other interactions. The results drawn from simulation shows the higher efficiency and fast route detection with better energy transmission of data through the network.

Keywords: Clustering, Distributional Heterogeneous Pathfinder, Lagrangian, Wireless Sensor Networks.

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1. INTRODUCTION

It is generally recognized that sensor communication in IoT systems takes place with large amounts of data transmission and interaction with the host system. Due to the minimal information needed to form routing selections and predict best paths, these will consume a high level of energy while transmitting data. The parameter can be extracted with several algorithms in the network region to form a cluster of sensor nodes. On the basis of distance prediction and in the form of cluster heads, these types of clustering methods reach maximum effectiveness [1]. Additionally, this may increase the energy consumption in a sensor network since each node must transmit massive amounts of data. In order to optimize this, the optimal routing protocol was developed to optimize cluster selection and provide solutions to the network's energy flow issues. Providing the best enhancement to the routing protocol, the proposed model emphasizes an efficient cluster prediction method to boost the performance of sensor system data transmission.

The Internet of Things is widely regarded as the third business revolution that implants computer science devices to data transmit (among sender and receiver) physically[2]. The number of physical objects is rising at a breath-taking rate, going from 2 billion in 2006 to 200 billion by 2020 [3] assuming a 200% growth rate. Sensors and devices for the Internet of Things are generally used to collect and analyse temporal and spatial data to achieve real-time events and to address various other tasks [4]. There is a rapid growth in IoT applications for various applications such as energy, education, healthcare, finance, smart cities and transportation [5]. Consequently, the scholarly world, industry and people are persevering to give security and wellbeing for example for IoT gadgets and organizations. These variables ought to mainly be worried to keep away from information disaster to the IoT clients. For instance, a brilliant home framework can be observed from a distance by the digital aggressors, and shrewd vehicle correspondence can be apprehended to make a sources of risk amongst the residents. This condition is exceptionally presented to network devices to influence the IoT safety frameworks and biological systems of complicated communiqué organizations, for example, network application, social networks, sites and Robotic systems for example botnet. [6]

Smart cities are becoming by using the parameters like, energy flow at each time instant, throughput, packet delivery ratio, error rate and other parameters to represent the efficiency of proposed work. A crucial component of smart, sustainable cities is effective traffic congestion mitigation in transportation. [8] When road capacity is exceeded by traffic demand, traffic congestion typically results. Enhancing the effectiveness of current traffic management systems is a possible solution because it is expensive to meet traffic difficulties by simply investing more in infrastructure. Through the Internet, IoT connects numerous digital items, building a sophisticated and extensive universal substructure for an information-driven culture. To create smart and sustainable cities that aim to improve both the performance efficiency of city operations and the quality of life for citizens, it can be integrated with cutting-edge information and communication technologies like edge computing, cloud computing, artificial intelligence and majorly smart grids. Traffic management systems can gather data via IoT.

Objectives of this paper are as follows:
- To understand the working of clustering under WSNs networks.
- To understand the working of DHP algorithm under WSNs
- To develop an enhanced technique for fast route prediction using above two techniques.
- To study the results drawn from experimentation under proposed scenario and compare them with other existing studies.

The paper is divided into six main sections. *Section I* deals with introduction to research work with basic explanation of concepts. *Section II* is about the related work for new proposed work. The *section III* deals with the explanation of proposed work mainly with the proposed methodology and algorithm. The *section IV and V* described about the experimentation and results. Last section VI contains conclusion of paper and future recommendations of the pproposed work.

2. RELATED WORK

Due to recent security concerns and advancement on a broad scale, IoT efficiency has emerged as a research area with the increase in the quantity and interconnectivity of smart devices. For improving IoT, a number of energy-efficient methods and solutions have been suggested. Here are a few examples:

The [Distributed-Multi-Hop-Adaptive-Tree-Based-Energy-Balanced] (DMATEB) method is refined and reported in [9]. It locates the node that is closest to the sensing node and has the most residual energy. It employs clusters to provide a multi-hop-routing mechanism, which is advantageous for increased data collection and network lifespan extension.

The Energy Aware Context Recognition Algorithm (EACRA) was introduced in [10] to prevent the repeated transmission of duplicate data. When the context changes at a specific moment, it communicates data from sensing devices, which reduces the amount of messages shared and saves energy. In terms of various network topologies, a performance analysis of the network is conducted. Sensing devices are only activated by the heating process; otherwise, they are inactive.

To ensure energy efficiency for large-scale deployments, the reliable-energy-efficient-route-selection (REERS) method was introduced in [11]. In an IoT setting, massive communication happens, demanding optimal route selection for data aggregation in critical application scenarios. The REER considers both hypothetical and real-time scenarios. An energy-aware routing protocol provides effective data routing while simultaneously decreasing energy consumption and latency by utilising low-cost paths for real-time applications.

The data aggregation from specific monitoring locations is shown in [12], where the efficient gathering of data is the main priority. The scheme's algorithm generates an appropriate path for agglomerating data from data-collection regions as well as agglomerating data from data-loaded regions.

The job offered helps to extend the network's lifetime by measuring the route cost from one region to another and then transmitting the load of each sensor node device. [13]

3. PROPOSED WORK

The suggested study employs a hybrid strategy that employs Clustering and the Lagrangian method with the assistance of the DHP routing protocol. To finish the proposed work, there are primarily three phases;

3.1 Proposed Model

The following characteristics are included in the proposed model:

Lagrangian Method: Mode selection is an energy-efficient, low-power and resource management strategy. To create the proposed method, the combinatorial fractional optimization problem for energy-efficient D-2-D communication is used to tackle mode selection, power management and resource allocation issues concurrently. The fundamental method employs a probabilistic approach to mode selection. To maximise energy efficiency, an iterative technique is applied to a fractional goal function, represented by the subtracted value. The best power value is obtained in each iteration using resource allocation and mode selection to maximise energy efficiency (EE), using a Lagrange-dual-function. As a Min-Max issue, Lagrange-multipliers are utilised to optimise the power with data rate, low transmit power rate, and interference limitations. [14], The lagrangian is the summation of unique neutral drive and a period that includes the practical limit and a 'Lagrange multiplier'. Suppose we overlook the practical limitation and consider the problem of maximizing the Lagrangian, subject only to the regional limitation.

DHP Protocol: The suggested protocol has been thoroughly investigated in the new deployed architecture in contrast to frequently used protocols. The suggested IoT architecture has two primary features: the capacity to form clusters depending on the prevailing degree of heterogeneity and the ability to communicate among several levels of heterogeneity. An innovative and practical IoT architecture that divides the network into regions based on the predominant energy level in each location. For example, a heterogeneous region may have a random distribution of regular nodes, the majority of which are normal restricted energy nodes and a few advanced-nodes. Other locations may have nodes with more rechargeable, energy and main-powered, and so on. [15].

Clustering Technique: The energy usage for data exchange varies due to the use of various types of small and large routing tracks. To accomplish improvement in heterogeneous-systems using energy-efficient approaches for routing based on hierarchy. An effective information collection strategy for a hybrid network is required. Usage of the collector node is to make a communication gathering from one or more sources constructed on configurable conditions. The basic study assumes that sensor node resources are consistent across the network. In this paper, we propose a system paradigm in which CH acts as a collector node for data received from member nodes. The important difficulty is recognising which CH has the highest remaining energy in order to improve network support and network life. Resulting the network is rebuilt so that the CH must transmit the largest number of neighbouring nodes possible. For long-term maintenance, the CH must carry the greatest amount of leftover energy possible [16].

3.2 Proposed Flow Diagram

The DHP-based routing algorithm was used in this optimum clustering system to anticipate the best routing path selection in the system as well as to minimize the energy usage in the network structure. [17] In this case, the routing model evaluates the characteristics of data packets in the network and predicts the cluster parameters of a network based on the given goal function of network's probabilistic key parameters. Then, the DHP find the optimal cluster in routing path to transmit the data packets based on the Lagrangian parameters. In this, it will identify the amount of energy level at each iteration cycle in the network. [18], [19] According to that matching point identification, the nodes that are formed clustered and find the matched class with best nearest point.

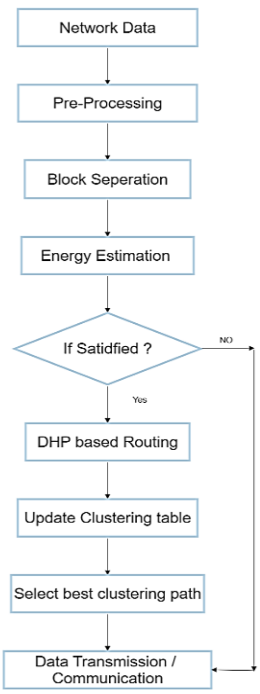

Figure 1: Flow diagram of proposed hybrid model

3.3 Proposed Algorithm

There are two major algorithms used for proposed work. That are as follows:

Algorithm 1: Distributional Heterogeneous Pathfinder (DHP) algorithm
Input: Node Parameters, F_s
Output: Selected Routing Path, T_s
Initialize Random Node structure U_i
For iter = 1 to N loop // 'iter' loop for maximum number of possible iteration count.
Estimate the cost value of the network structure as $C(P_{iter}) = \frac{1}{2}(Z - a_2)^2$
Where, a_2 – Parameters of nodes in the network region.
P_{iter} – Linearity estimation for each iteration count.
Z – Index for selected node in the range.
Estimate weight value by the representation of F_{iter}
$F_{iter} = \frac{1}{l}(Z_{iter} - a_2(iter))f'(J(P_{iter})_2)$
Ensemble the cluster of nodes that are related to the weight value.
If $(F_{iter-1} > F_{iter})$, then
Select the best route path with 'F' as T_s.
End If
$T_s(iter) = F'_{iter}$
End loop 'x'

4. RESULT

Experimental results have demonstrated the process of proposed work by taking an example prototype as shown in below figures. The results shown are as below

4.1 Throughput

Comparison results of this research work with other previous techniques for average throughput is presented below through *table 1* and *figure 2*.

Table 1: Comparison results of this research work with other previous techniques for average throughput

Nodes	Average Throughput			
	QU-RPL	**OHCA**	**CAFOR**	**Proposed**
n7	10	15	16	17
n8	11	12	17	19
n9	15	16.4	19.7	22
n10	16.4	17	17.7	18

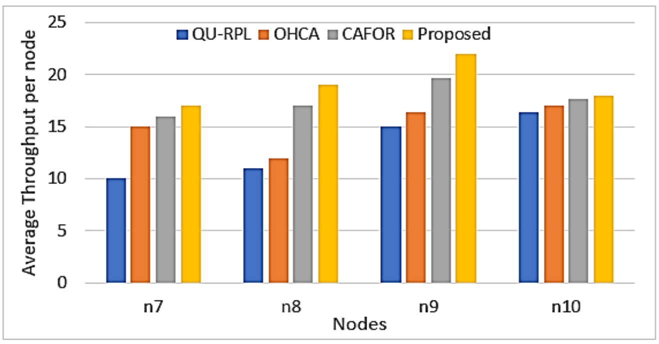

Figure 2: Comparison results of this research work with other previous techniques for average throughput

Above results of average throughput shows the as per the no. of nodes increased the average value of throughput is balanced for proposed work as compared to other techniques.

4.2 Delay

Comparison results of this research work with other previous techniques for average delay is presented below through *table 2* and *figure 3*.

Table 2: Comparison results of this research work with other previous techniques for average delay

Time (Sec)	Average Delay			
	QU-RPL	OHCA	CAFOR	Proposed
60	8	5.8	6.5	5.6
120	8.5	6.3	6.7	6.2
180	8.8	6.5	6.9	6.3
240	9.1	6.8	7.2	6.5

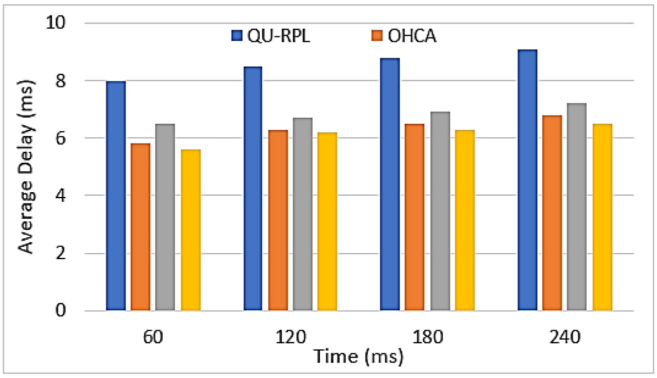

Figure 3: Comparison results of this research work with other previous techniques for average delay

Above results of delay shows the as per the time unit (ms) increased the average value of delay is balanced for proposed work as compared to other techniques.

4.3 Packet Loss Ratio

Comparison results of this research work with other previous techniques for percentage (%) of packet loss ratio is presented below through *table 3* and *figure 4*.

Table 3: Comparison results of this research work with other previous techniques for percentage (%) of packet loss ratio

Number of Packets	Packet Loss Ratio (%)				
	TOPSIS	DDRL	WOLF-PHC	TPE-AODV	Proposed
2K	100	120	130	90	80
4K	200	240	260	180	160
6K	300	380	390	270	240
8K	400	500	520	360	320
10K	500	620	650	450	400

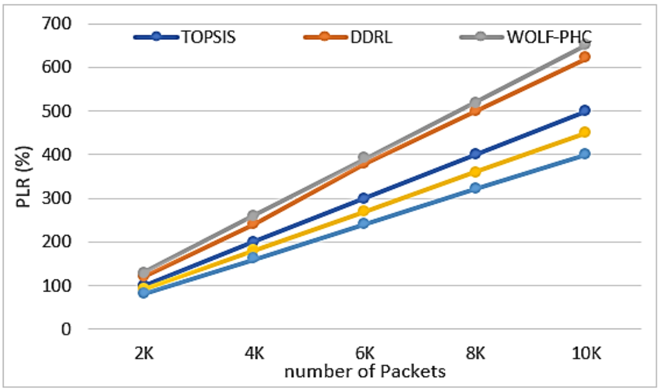

Figure 4: Comparison results of this research work with other previous techniques for percentage (%) of packet loss ratio

Above results shows the as per the number of packets increased the percentage of packet loss ratio is decreased for proposed work as compared to other techniques.

4.4 End-to-end delay

Comparison results of this research work with other previous techniques for end-to-end-delay value is presented below through *table 4* and *figure 5*.

Table 4: Comparison results of this research work with other previous techniques for end-to-end-delay value

Number of Packets	End-to-End- Delay value				
	TOPSIS	DDRL	WOLF-PHC	TPE-AODV	Proposed
5K	0.73	0.68	0.52	0.48	0.375
10K	1.27	1.2	1.1	0.95	0.865
15K	1.87	1.72	1.68	1.42	1.325
20K	2.5	2.24	2.22	1.89	1.75
25K	3.2	2.76	2.64	2.36	2.08

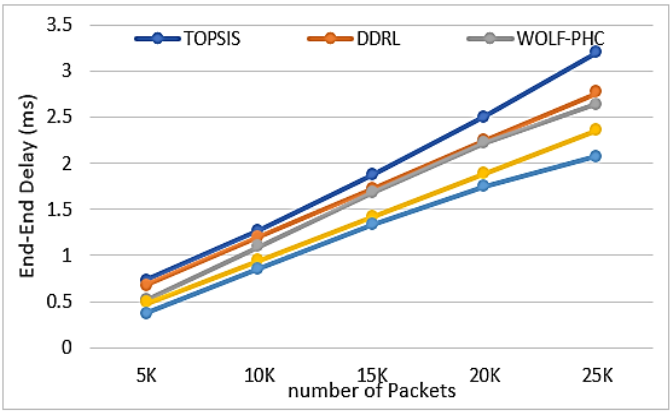

Figure 5: Comparison results of this research work with other previous techniques for end-to-end-delay value

Above results shows the as per the number of packets increased the value of end-to-end-delay is decreased for proposed work as compared to other previous techniques.

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4.5 Packer delivery ratio

Comparison results of this research work with other previous techniques for packet delivery ratio is presented below through *table 5* and *figure 6*.

Table 5: Comparison results of this research work with other previous techniques for packet delivery ratio

Number of Nodes	Packet Delivery Ratio (%)					
	MFC	CARF	FCC	GTR	CCOR	Proposed
100N	0.5	0.48	0.43	0.37	0.3	0.26
150N	0.85	0.8	0.7	0.57	0.45	0.36
200N	1.35	1.18	1.05	0.85	0.7	0.54
250N	1.7	1.58	1.35	1.15	0.9	0.73
300N	1.85	1.75	1.6	1.35	1.17	1.02

Below results shows the as per the number of packets increased the percentage value of packet delivery ratio is increased for proposed work as compared to other techniques.

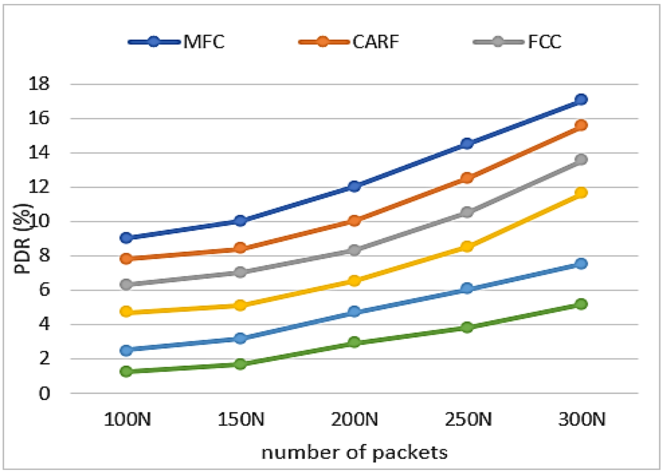

Figure 6: Comparison results of this research work with other previous techniques for packet delivery ratio

4.6 Energy consumption

Comparison results of this research work with other previous techniques for energy consumption is presented below through *table 6* and *figure 7*.

Table 6: Comparison results of this research work with other previous techniques for energy consumption

Number of Nodes	Energy Consumption					
	MFC	CARF	FCC	GTR	CCOR	Proposed
100N	9	7.8	6.3	4.7	2.5	1.23
150N	10	8.4	7	5.1	3.2	1.67
200N	12	10	8.3	6.5	4.7	2.87
250N	14.5	12.5	10.5	8.5	6	3.8
300N	17	15.5	13.5	11.6	7.5	5.15

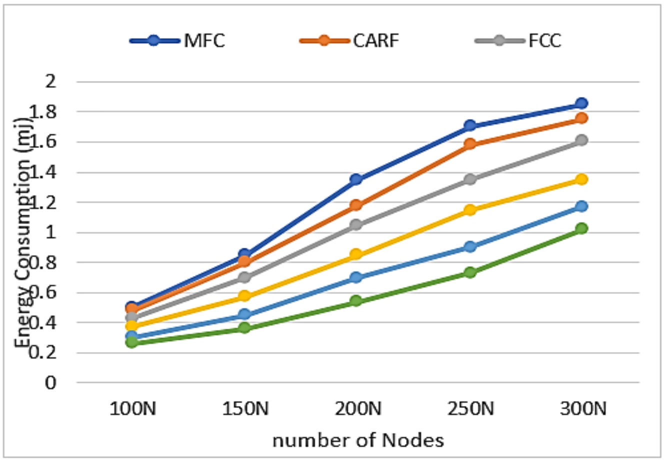

Figure 7: Comparison results of this research work with other previous techniques for energy consumption

Above results shows the as per the no. of nodes increased the amount of energy consumption is decreased for proposed work as compared to other techniques.

5. CONCLUSION

Data routing is a key topic in IoT networks. By their very nature, IoT devices are resource restricted, and the majority of them operate with insufficient security. From proposed work of identified result performance of matching prediction of any cluster to analyse the overall energy consumption. The proposed method is implemented in the python scripting and improved the performance by using the parameters like, energy flow at each time instant, throughput, packet delivery ratio, error rate and other parameters to represent the efficiency of proposed work. This proposed hybrid model presented the improved results when compared to other existing techniques. For future work some problems related to cost effectiveness and time efficient calculation and comparisons to other existing algorithms can be considered.

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