An Enhanced Hybrid Energy Optimization Routing Protocol for Bio-Inspired WSN

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Abstract

Recently swarm intelligence routing protocol providing a way better role in bio-inspired technology to cover optimal solutions in WSN. High energy consumption and mobility awareness are the foremost issues related to bio-inspired technology. To resolve this crucial problem of bio-inspired WSN during a very dynamic model and intermittent connectivity may well be a challenging one. The goal of this project is to implement the optimal routing mechanism to develop the mobility of designed network further as energy-efficient in bio-inspired WSN by implementing HEED (Hybrid Energy-Efficient Distributed clustering) clustering technique for cluster formation of network system and HPSOPIO(Hybrid Routing Protocol Of Particle Swarm Optimization and Pigeon Inspired Optimization) for selection of the cluster heads and search optimal solution of BIO inspired WSN. The performance metrics of this proposed work like energy consumption, end-to-end delay, packet delivery ratio, throughput, network lifetime, and routing overhead ratio are evaluated to test the protocol with the Ant Colony Optimization (ACO) and Ad hoc on Demand Distance Vector (AODV). The results of the tests reveal that the proposed routing protocol (HPSOPIO) reduces the energy consumption and might increase the lifetime of the network compared with the ACO and reactive routing protocol of AODV.

Keywords: Wireless Sensor Technology (**WSN**); Hybrid Energy-Efficient Distributed clustering (**HEED**); Hybrid Routing Protocol of Particle Swarm Optimization and Pigeon Inspired Optimization (**HPSOPIO);** Ant Colony Optimization **(ACO)** and Ad hoc On-Demand Distance Vector (**AODV**)

I.INTRODUCTION

The cluster of WSN tweaking the key enablers for several applications like industrial automation, embedded systems, biomedical instrumentation. The projected design is an autonomous routing structure Associate with no clusters by the exploitation of the HEED technique and HPSOPIO routing protocols. These device nodes can operate the packet transmission among themselves within their foreseen region and besides, they are provided the mandatory informatory for the physical entity of the WSN system The planned theme is to defend against the variable power level of every node at a low level throughout the information transmission from sink nodes to multiple base stations of the WSN network. The communication between sink nodes and a base station within the formation of HEED protocol that will increase the promising period of the sensing element network. Furthermore, The selected head node of each cluster is chosen by the planned routing rule (HPSOPIO) for every cluster referred to as cluster head to distribute the information from the corresponding node and transmit to the target station with cost-effective multi-hop transmission. Most of the prevailing algorithms and protocols tried to reinforce their best performance of the networks in terms of analysis criteria like quality of network and energy-efficient, lifetime, and fitness operation. However, the planned routing protocol (HPSOPIO) was altered the routing structure on the network layer level and providing the optimum coverage for quality and enhancing the improved bio inspired WSN. The distance property of every node is computed to choosing nodes to function as CH to attain the maximum life period of the entire system. HPSOPIO is associate with the heed technique to

enhance the improvement technique of self-learning behaviors to optimizing minimal path computation of the entire system

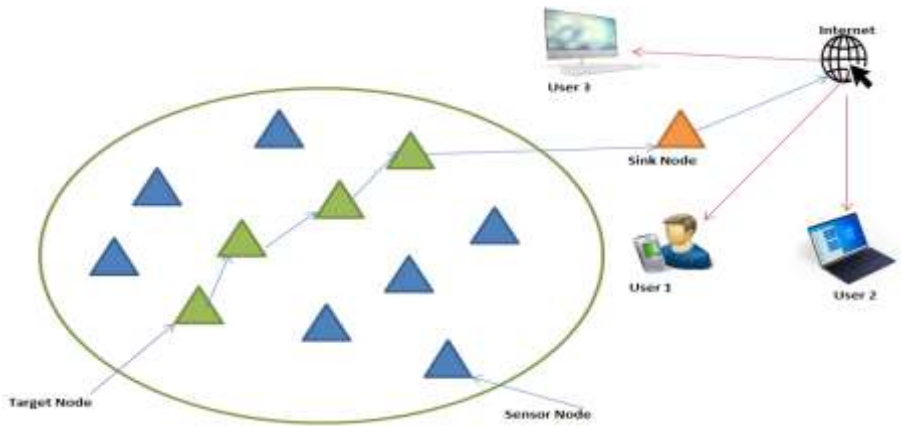

Figure1: The Architecture Diagram Of Wireless Sensor Network

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1.1 Thesaurus of the Work

To magnify the generated WSN befittingly several demand routing protocols and swarm intelligence techniques are familiar with fulfilling the appliance needs in WSN. To execute this research works to resolve a part of the energy consumption of every sensor node among other sensor nodes while communicating by using heed clustering and proposed routing protocol (HPSOPIO). The HEED Based Clustering and planned routing architecture has been made to retain in single-hop communication pattern within each cluster and allowed the multi-hop communication among the CHs and BS.

II. RELATED WORKS

WSNs have Hierarchical structure routing protocols that are appropriate for data communication since they'll provide sensible quantifiability and effectively organize sensor nodes. LEACH (Low-Energy Adaptive Clustering Hierarchy) [2] clustering provides network lifetime improved way of the wireless sensor network. Mobile sink node has been used instead of fixed sink node and cluster heads also rotated for each round to enhance their residual energy and life span of WSN.

The reactive routing protocol AODV [5] performance has been improved by utilization of Paillier homomorphic cryptographic mechanism for building the security layer to secure packet loss and optimal routing during the communication and data transmission of WSNs architecture. It provides confidentiality of secure routing packet and integrity of data transmission by implementing SL-AODV to enhance their improvement of on demanding routing AODV protocol

In paper [8] the particle swarm optimization (PSO) using the multiagent stochastic parallel technique for cluster formation in MANETS and evaluating the multiobjective fitness function of the network.it shows that the formation of clustering will be appropriate for energy-efficient and better mobility of MANETS in which different multi-hop sensor nodes are connected with multiple hosts' autonomous systems.it proves that it modified network will suitable for cost-effective infrastructure network like military service, vehicle to vehicle communication, transport communication, rescue operation.
Paper [6] to enhance global optimal solution in bio-inspired technology the hybrid routing protocol is introduced to improve the flexibility of exploitation in Particle Swarm optimization with the flexibility of exploration in Grey Wolf Optimizer to supply each variants' strength. Some unimodal, multimodal, and fixed dimension

multimodal test functions are accustomed to check the resolving ability and performance of the HPSOGWO variant .it is low-level l as a result of they tend to merge the functionalities of each variant. it's evolutionary as a result of they have not used each variant In alternative ways that, they run in parallel. it's mixed as a result of each variant are concerned in generating final solutions to the issues.

The author developed the hybrid method [9] of PSO (HPSO) to solve this drawback by combining space transformation search (STS) with a brand new changed speed model. Experimental studies on eight benchmark functions evaluate that the HPSO holds sensible performance. In earlier [10] these hybrid algorithms are geared toward reducing the chance of trappings in native optimum HPSOAC. Recently a fresh bio-inspired WSN improvement technique is originated, specifically HPCOGWO. Another method[11] has been made **to** improve the energy efficiency for MANETS application by enhancing proactive protocol of the Optimized Link State Routing (OLSR) protocol tweaking by bat optimized link-state routing protocol (BOLSR) in the MANET. An ad hoc network refers to one session association that doesn't use wireless base stations or routers [12] and is principally developed for short-lived network connections. During this quiet network, all nodes participate in the routing activities while not the employment of any infrastructure. rather than classic routing, a flooding technique is utilized by the network for information transition [14].

III. METHODOLOGY AND MATERIALS

This paper describes an energy and mobility aware routing protocol for the WSN. The main components of the analysis are Clustering formation, HPSOPIO Routing Protocols, and, tested network analysis metrics.

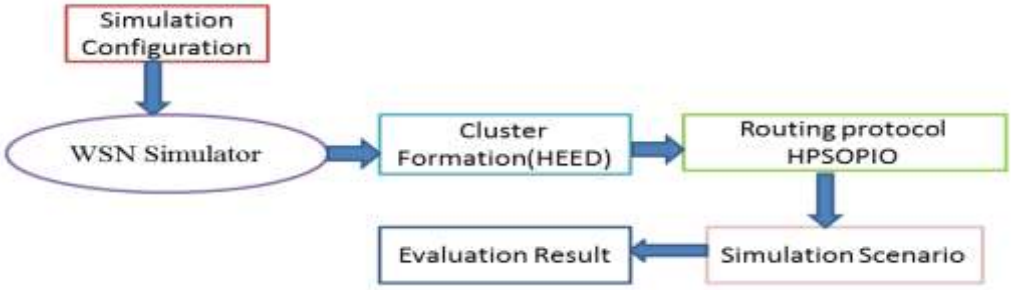

Fig 2: The Schematic Diagram of Proposed Methodology

3.1 Cluster Formation (HEED):

WSNs contain an oversized range of sensors starting from 50 to 200. the primary step involved throughout this section is that the plotting of sensing element nodes throughout a 250*250 m sq. region. The preparation of created nodes (200) in multiple base stations is then illustrated as 2 dimensions and energy of 4 joules is assigned for sensing element nodes .the required cluster is made by multiple base stations or sink on basis of HEED technique. In the WSN network, multiple base stations (sink) can broadcast data assortment messages to any or all sensing element nodes. HEED provides a collection of CHs to retain the residual energy criteria for every node and socially connected structure among variable power level of sensing element nodes are used when communication on both single-hop and multi-hop communication

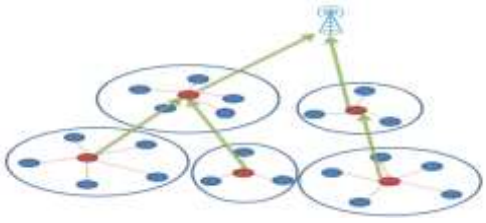

Fig 3: The Cluster Formation (HEED)

The HEED technique defines a cluster and power level of each sensor nodes of this network to achieve the most utilization of spatial reprocess and lower level of nodes when multi-hop communication is processed.it will facilitate to make sure a socially connected wireless network, and better power level of each sensing nodes have been created as greater than cluster diameter. This specific constraint can guarantee balanced intercluster data communication throughout the system communication method. The communication cost size will be set by the analysis of parameters like power level, degree of connectivity on each node.it can as calculated by

$$AMPR = \frac{\sum_{i=1}^{M} MinPwr_i}{M}$$

The bio-inspired WSN network consists of cluster initialization by using the HEED cluster technique to ensure as follows:

1) Sensor nodes make a dynamic and services to a mobile agent

2) The power levels of sensor nodes are assigned to achieve the utilization of appropriate energy level during multi-hop communication between the base stations

3) The created sensor nodes by using the Proposed technique (HEED) is to have similar processing during the data communication and left unattended after deployment

4) To ensure the time interval condition TNO>>TCP when processing the networks

In where TNO is the protocol operation time interval, TCP is the clustering time interval

5) Clustering provides services to an assessment of cluster head selection for proposed routing protocol (HPSOPIO) to enhance the energy efficiency as well as mobility of bio-inspired WSN.

3.2 Proposed HPSOPIO Routing Algorithm

In this section, we propose an Enhanced HPSOPIO (Hybrid of Particle Swarm Optimization and pigeon inspired optimization) algorithm cluster head selection after the formation of sensor nodes by using the HEED cluster algorithm. The particle swarm optimizer offering the random solution of the system by recentralized the cluster heads and search the optimal solution in each generation. The PSO invariably tries to change the velocity of each particle towards the robust path of its network. The velocity is set by randomly generated numbers for velocity towards its objective solution to minimize the energy consumption of each node. The optimal solution of this particle swarm optimizer can be determined by magnified velocity until to get find the best solution of the network. Based on the fitness function value of each generation the process can be moved to individual landmark operators of pigeon block to get feasible solutions for the WSN network. The individual data point from swarm optimizer is given into the self-learning search model of pigeon inspired optimizer.

3.2.1 Algorithm for HPSOPIO

Let $X = \{x_1,x_2,x_3,\ldots\ldots,x_n\}$ be the set of data points and $V = \{v_1,v_2,\ldots\ldots,v_c\}$ be the set of centers.

1) Randomly select *'c'* cluster centers.

2) Calculate the distance between each data point and cluster centers.

3) Assign the data point to the cluster center whose distance from the cluster center is the minimum of all the cluster centers.

4) Recalculate the new cluster center using:

$$v_i = \left(1/c_i\right)\sum_{j=1}^{c_i} x_i$$

Where *'c_i'* represents the number of data points in the cluster.

5) Recalculate the distance between each data point and newly obtained cluster centers.

6) If no data point was reassigned then stop, otherwise go to the next step 7).

7) First initialize the flock of pigeons, Assigned to the first pigeon of a group of pigeons, a positive random fitness value *F*1, By default, It is in the optimal group E0

8) Then the fitness value is assigned according to the nearest distance of each individual in the pigeon group and the individual in the optimal group

$E_n = \{e^{(m)}, m = 1,2, \dots M\}$M is the total number of individuals in the optimal group. Each optimal individual e(m) has k function values.

9) The formula of the distance between the *I* pigeon and the *m* pigeon in the optimal group is as follows:

$$d^{(m)}(i) = \sqrt{\sum_{j=1}^{k} \frac{e_j^{(m)} - f_j^{(m)}}{e_j^{(m)}}}$$

10) each pigeon can be more rationalized according to the individual's fitness value and the distance from the optimal solution and Find the best solution.

3.3 Simulations Model

The simulation of the projected HPSOPIO protocol is mentioned during this section by using the network simulator NS2.34 version. The experimental tests of the simulation aim to enhance the Bio-Inspired Technology of WSN performance and prolong its lifetime. the target is to use the HPSOPIO to seek out the trail with the best levels of energy and mobility of the network. the projected routing Protocol HPSOPIO is tested and their results are compared with the existing protocol of ACO and reactive protocol of AODV. Initially, the WSN environment module has was created to process the simulate the entire network by using HEED based cluster technology. This module consists of most characteristics of network size, variety of nodes, packet details, and information measures .the consecutive step was implementing the planned routing protocols as during of progress in which many improvement algorithms were tweaked to resolve the better solution of the progress. Different eventualities(no of nodes and node speed) with varied parameters of WSN structure were enforced in the next step to assess the performance quality of the proposed protocol. Performance metrics of, E2E, packet delay Ratio, network lifetime, energy consumption, and throughput was evaluated. Finally, a result in the visual image graphical interface module is enclosed to look at the results and connected analysis.

Table 1.The Simulation Parameters.

Parameter	Value	Unit
No. of nodes	200	-
No of iteration	120	-
Initial energy	4	Joule
Packet Size	512	Byte
Transmission Range	250	m
Protocol	HPSOPIO, ACO, AODV	-
Area	225*225	Sqm
Nodes	(50-200)	
Simulation time	(10–70)	m/s
Node speed	4-24	m/s
Traffic type	CBR/UDP	-
Packet size	512	byte
Transmit power	2.5	Joule
Reception power	1.9	Joule
Idle power	0.06	Joule

3.2.1 Performance Metrics

Varying metrics are accustomed to appraise wsn network performance with projected routing protocol the most important challenges for heed based clustering wsn routing include the Energy Consumption, Network Lifetime E2E delay, PDR, , throughput. Different solutions are provided for varied routing issues, like security, EC, bandwidth, and QoS. The metrics mentioned within the following subsections were evaluated the performance of the projected algorithm (HPSOPIO) with ACO and reactive protocol (AODV).

EC

EC is employed to calculates that energy used by every node whereas simulation time.it refers to the magnitude relation between total energy consumed by every node and the basic energy level of every node once the simulation

$$EC = \sum_{i=1}^{n} ini(i) - ene(i)$$

NETWORK LIFETIME:

This metric evaluates the time at that the first node becomes failure owing to the discharge of the battery power charge. The number of alive nodes of the network in every simulation is pictured

E2E: END-to-END delay refers to the time taken for a packet to be transmitted across a network.

$$E2E\ delay = \frac{\sum_{i=1}^{n}(Ri - Si)}{n}$$

where n indicates that the total size of packets that are received by destination nodes, I indicate that the distinctive packet,Ri refers to the receiving time of the packet with i, and Ri denotes the transmission time of the packet with i.

PDR: packet delivery ratio is a quantitative relation between the total packet drooping ratio concerning the packet transmission of the WSN communication.

THROUGHPUT

Throughput refers to that packet transmitting ratio per second or successfully deliver data ratio over a WSN communication channel at simulation is processed

ROR:

ROR is that group of routing packet ratio between routing packet (RP), and delivered data packets .in where (RP) routing packets indicates that spending packets to discover all the nodes in the network. While DDP refers to the actual information that's transmitted from supply to destination nodes

IV.EXPERIMENTAL RESULTS AND DISCUSSION

In this research work, The experimental Section provides a short discussion of the results of the projected HPSOPIO protocol compared with existing protocols of ACO and AODV. The performance metric that was magnified to test the performance of the planned protocol includes the parameters of EC, network lifetime, E2E delay, PDR, throughput, and ROR. The analysis metric of the tests was associated with the parameters of a variety of nodes, node speed. This simulator created the WSN environment used heed algorithm to form clusters and HPSOPIO routing protocol to select the cluster heads for resolving the mobility and energy efficiency of the WSN. Simulation results are created, by deploying 200 nodes among a 225 ∗ 225 Sqm space. The sensing element nodes are deployed with the task of sensing physical parameters.

Table 2: The change in parameters for the no of nodes

PARAMETER	PROTOCOL MODEL	50	80	110	140	170	200
EC(J)	HPSOPIO ACO AODV	**13.52** **15.68** **17.25**	**15.69** **18.69** **19.36**	**19.63** **20.41** **23.65**	**23.41** **25.36** **26.85**	**24.56** **26.12** **28.96**	**26.36** **28.96** **31.25**
Network lifetime	HPSOPIO ACO AODV	**26532.21** **21521.18** **18896.36**	**19563.96** **15968.85** **12874.96**	**15365.65** **11965.96** **8963.41**	**13698.85** **8756.12** **6521.54**	**11523.36** **6123.63** **4145.25**	**9654.63** **4658.14** **1965.13**
E2E (S)	HPSOPIO ACO AODV	**22.71** **27.65** **29.83**	**20.65** **25.65** **28.69**	**18.45** **24.74** **27.96**	**15.98** **21.96** **23.65**	**14.65** **20.12** **21.96**	**11.56** **19.56** **21.41**
Packet Delivery Ratio (%)	HPSOPIO ACO AODV	**78.5** **76.22** **75.45**	**84.5** **81.65** **79.68**	**87.32** **83.74** **81.85**	**91.23** **86.74** **83.52**	**93.65** **87.63** **85.35**	**95.65** **89.54** **88.74**
Through Put (b/S)	HPSOPIO ACO AODV	**31589.65** **27963.63** **27563.65**	**32569.96** **28965.14** **29632.52**	**35698.45** **30145.36** **30965.85**	**37521.88** **32521.36** **33552.21**	**39632.54** **34587.25** **35214.52**	**42965.8** **37125.63** **38521.21**

In this analysis work, the subsequent performance metrics are taken for evaluating the WSN to provide efficient network potency by saving energy and improve network lifetime. Metrics are evaluated for various rounds from 50, 80, 110, 140, and 200, and the corresponding outputs Illustrated as a graph. The two WSN plots of the tests were associated with the parameters of a variety of nodes, node speed. These parameters were altered to watch their effects on the EC, Network Lifetime, PDR, E2E delay, and throughput of the HPSOPIO, ACO, and AODV protocols. Its value mentioning that the figures below depict the effects of those Performance Metric parameters in different eventualities of the HPSOPIO protocol to retain on reducing energy consumption, increasing the Life span of the network. Simulation results are evaluated concerning the performance metrics of the planned HPSOPIO algorithm in distinction with the competitive existing algorithmic rule that's shown in Table1.

The impact of the range of nodes on energy consumption for these three routing protocols concerning the no of nodes is shown in Figure 4. The energy consumption of nodes steadily increase with no of nodes increased, and also noted that HPSOPIO has a very low energy consumption of given WSN environment when a dynamic change in no of nodes while AODV has high energy consumption.

From fig 5, we noticed that the network lifetime is going to be decreased with no nodes increased, the proposed routing protocol enhances their prolonged network lifetime when no nodes increased. The results obtained during the simulation of the third metric are shown in Figure 6 and it cleared that the effect of the no of nodes on E2E delay of the HPSOPIO, ACO, and AODV protocols. The results show that end to end delay of those three routing protocols is steadily decreased when no of nodes increased. It proves that The HPSOPIO reaches the smallest E2E delay as a result of the increasing no of nodes offers it the flexibleness to identify nodes with higher energy capability that stabilizes of routing path.

Figure 7 shows the packet delivery ratio that obtained by implementing the HPSOPIO is significantly inflated at 95.65% for max no of nodes (200) compared with existing routing protocol system ACO, and therefore the reactive protocol of AODV has an all-time low share consequently 89.54 %,88.74 you look after packet delivery ratio. Fig 8 depicts the advance of throughput using HPSOPIO varying with no of nodes is shown and comparison also analyzed with ACO and AODV.

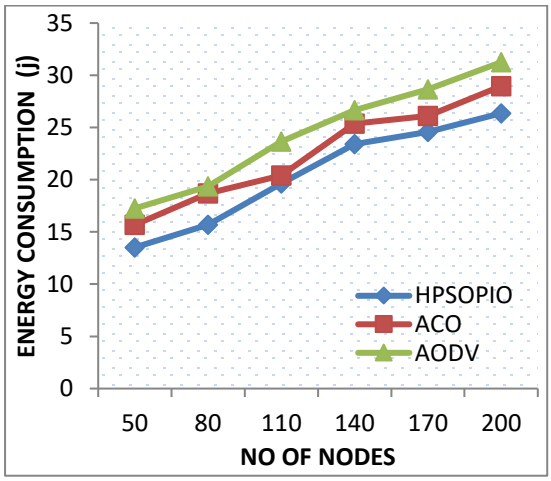

Fig.4: No of Nodes vs EC

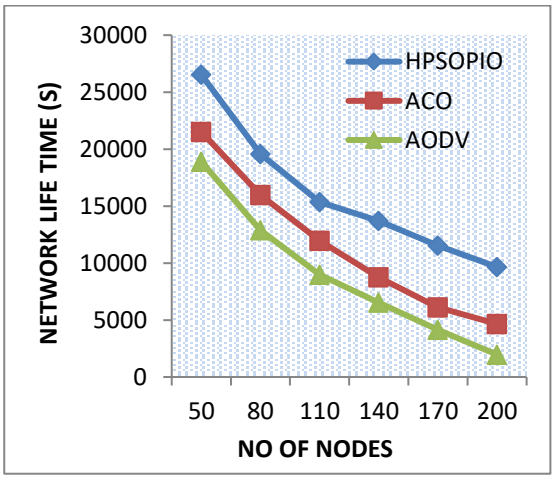

Fig.5: No of Nodes vs Network Life Time

The tested magnified value of performance metrics such as E2E delay, packet delivery ratio, energy consumption, and routing overhead ratio is generated concerning the node speed of projected architecture that's shown in table 3 The prediction of node speed on energy consumption of HPSOPIO, ACO, and AODV is shown in fig 9 .the clearly states that EC of each node will be increased gradually during node speed processed as high can makes link failure between nodes.it proves again the energy consumption of HPSOPIO is lesser than ACO and AODVThe depiction of node speed on the ROR of the three protocols is shown in Figure 10

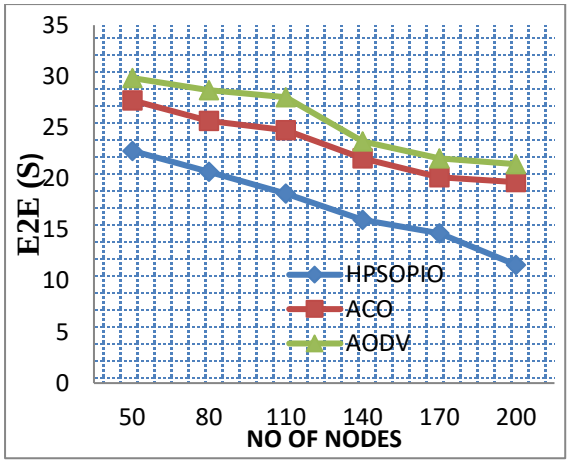

Fig.6: No of Nodes vs E2E

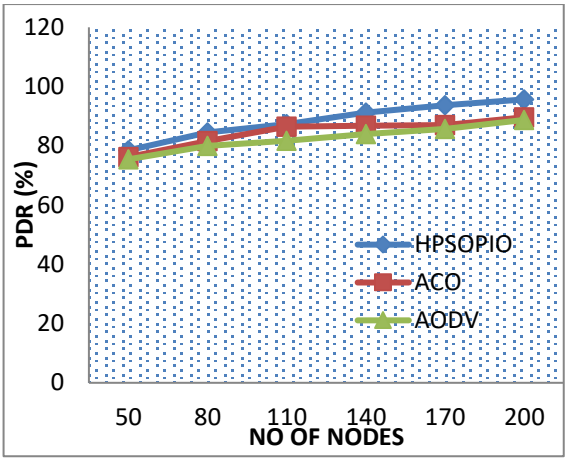

Fig 7: No of Nodes vs PDR

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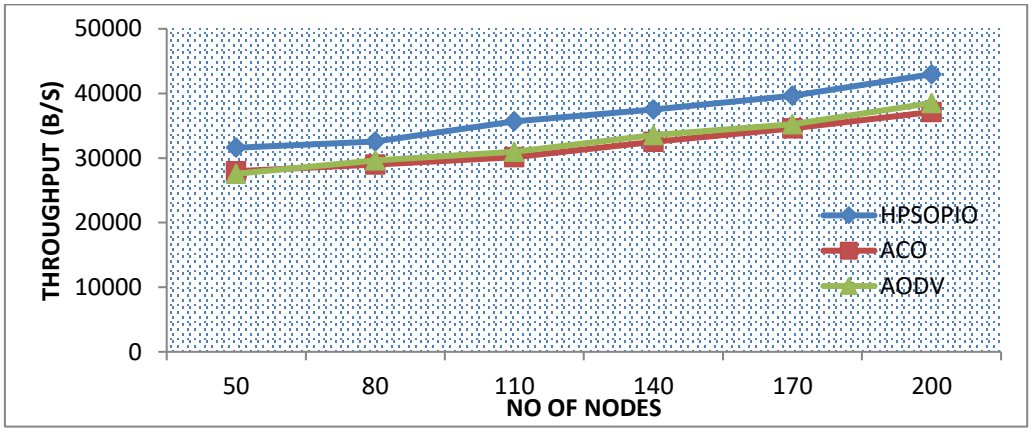

Fig 8: No of Nodes Vs Throughput

Table 3: The change in parameters for the node speed

PARAMETER	PROTOCOL MODEL	4	8	12	16	20	24
EC(J)	HPSOPIO	18.63	21.36	25.36	27.65	29.65	32.65
	ACO	22.54	24.69	26.54	28.41	31.36	36.25
	AODV	26.35	29.63	32.65	36.25	39.63	41.69
ROR	HPSOPIO	16.96	19.36	21.65	24.65	27.63	29.31
	ACO	18.50	21.63	23.65	26.35	29.65	32.65
	AODV	19.63	24.65	25.65	29.65	31.65	34.65
E2E (S)	HPSOPIO	13.7	19.63	25.69	31.68	36.25	43.69
	ACO	16.8	22.96	28.69	35.69	39.65	49.74
	AODV	19.87	26.36	32.58	38.52	41.36	53.69
Packet Delivery Ratio (%)	HPSOPIO	75.63	73.65	71.65	68.56	66.87	63.25
	ACO	82.15	80.63	79.36	77.96	76.96	74.36
	AODV	83.65	82.65	81.85	79.63	77.12	76.41

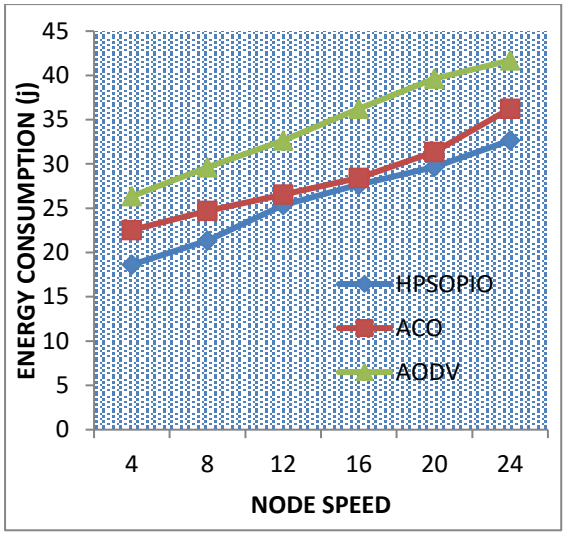

Fig 9: Node Of Speed Vs EC

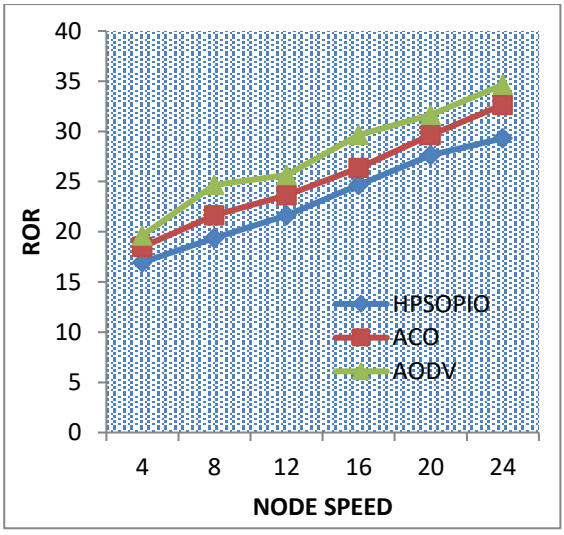

Fig 10: Node Of Speed Vs ROR

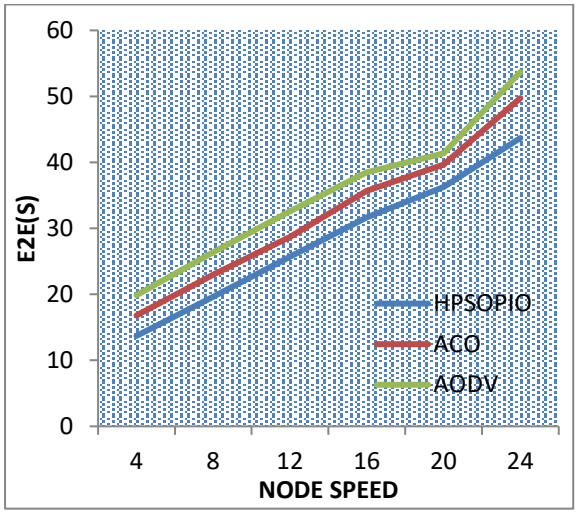

Fig 11: Node Of Speed Vs E2E Delay

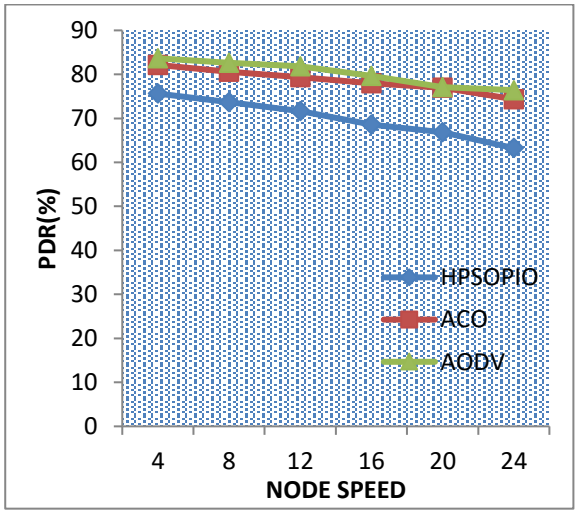

Fig 12: Node Of Speed Vs PDR

It states that the routing overhead ratio (ROR) of proposed HPSOPIO is tested and compared with ACO and AODV for high node speed from 4-24 m/s.it shows that ROR gradually increased with the increasing of node speed. it states that HPSOPIO provides better than an ACO and AODV.

The impact of node sped on E2E delay of the HPSOPIO, ACO, and AODV is shown in fig 11. the causes of high probability link failure between each node when dramatically increasing the node speed, E2E delay of routing protocols also increased.it states that HPSOPIO has a min E2E delay with regards to high node speed. The packet delivers ratio is reduced when node speed enormously increased within the proposed HPSOPIO algorithm relatively in comparison with the competitive algorithm OF ACO and AODV which is shown in Figure 12.

V. CONCLUSION

The technology of WSNs has evolved into a desirable field of analysis as a result of its several promising characteristics. Recently many researchers are using the robust setup of WSN technology to resolve the energy usage and mobility of the WSN environment. In this project, the HPSOPIO protocol was proposed and simulated in the WSN environment using the ns2 simulator. the improved clusters have been made by HEED

clustering as a way to access the routing path of the proposed HPSOPIO routing protocol in data communication of multi-hop transmission. the performance metrics of EC, network lifetime, PDR, ROR, E2E, and throughput were estimated for no of nodes and node speed .the performance evaluation present that the HPSOPIO protocol outperforms ACO and reactive protocol of AODV .the proposed routing protocol proves that ability to optimize the robust path of nodes have the lowest energy consumption and prolonging the network lifetime.

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