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An Efficient Leader Node Selection for Movable Nodes in WSN using PSO Technique

J.Jegan, S.Siva Kumar, A.Ramachandran, S.Md.Shafiullah

Abstract*: Wireless Sensor Networks (WSN) is a group of sensor devices, which are used to sense the surroundings. The network performance is still an issue in the WSN and an efficient protocol is introduced such as LEACH. To improve the stability, LEACH with fuzzy descriptors is used in preceding research. However the existing has drawback with effective group formation in heterogeneous WSN and also it is not achieved the Super Leader Node (SLH). To overcome the above mentioned issues, the proposed system enhances the approach which is used for increasing the energy consumption, packet delivery ratio, and bandwidth and network lifetime. The proposed paper contains three phases such as grouping formation, Leader Node (LN) selection, SLN selection with three main objectives:(i) to acquire Energy-Efficient Prediction Clustering Algorithm (EEPCA) in heterogeneous WSN for grouping formation (ii)To design Low Energy Adaptive Clustering Hierarchy- Expected Residual Energy (LEACH-ERE) protocol for LN selection.(iii)To optimize the SCH selection by Particle Swarm Optimization (PSO) based fuzzy approach. The clustering formation is done by Energy-Efficient Prediction Clustering Algorithm (EEPCA) in heterogeneous WSN. It is used to calculate the sensor nodes which have shortest distance between each node. The LEACH-ERE protocol was proposed to form a Leader Node (LN) and all the nodes has to communicate with sink through LN only. New SLN is elected based on distance from the sink and battery power of the node.

***Keywords*: Leader, Energy, heterogeneous,**

I. INTRODUCTION

A WSN is individual as a gathering of a huge amount of less battery power, less cost and various functional sensor nodes which are haphazardly and extremely distributed either privileged the scheme or very adjacent to it [1]. Sensor nodes which are actually small in size comprise of a sensing unit, data processing unit, and geographic positioning scheme, power supply unit like battery or solar cell and communicating constituents such as radio organizations.

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* Correspondence Author

J.Jegan*, Associate Professor Department of CSE Sreenivasa Institute of Technology and Management Studies, Chittoor

S.Siva Kumar, Associate Professor Department of CSE Sreenivasa Institute of Technology and Management Studies, Chittoor

A.Ramachandran, Assistant Professor, Department of CSE, B.S.Abdur Rahman Crescent Institute of Science and Technology, Chennai (Tamil Nadu), India. E-mail: msg2chandran@gmail.com

S.Md.Shafiullah, Research Scholar, Department of CSE, SCOPE-Vellore Institute of Technology, Vellore (Tamil Nadu), India. E-mail: smshafi@gmail.com

It establishes the basis of a broad collection of applications associated to public security, observation, armed, physical condition care, and green monitoring.

Generally, WSNs are strongly organized in hazardous places where batteries revive or substitute is closely insufferable and individual observe scheme is really dangerous. The outdated routing protocols have many confines at what time useful to WSNs, which are typically remaining to the power constrained environment of such networks [2]. Smallest amount Energy Communication Network [3] is a location based protocol for manage smallest amount energy for haphazardly organized ad hoc networks, which hard work to set up and preserve a smallest amount energy system with mobile sensors.

In [4] an power proficient uniform grouping procedure for WSN in which the duration of the system is enlarged by guaranteeing a uniform division of nodes in the groups. Grouping systems of support different message display comparing balanced, one to each of the, one to any, one to many, and numerous to one. The bunch head and comparing data identified for group creation in wireless sensor networks.

In uniform networks, the static grouping selects leader nodes only once for the complete epoch of the system. This outcome in excess on leader heads. As anticipated in LEACH protocol [5], [6], the part of leader nodes is haphazardly and occasionally alternated over all the nodes to guarantee the similar rate of indulgence of energy power for all the wireless nodes.The LEACH-ERE algorithm [7] practices two parameters: outstanding power and expected residual energy (ERE) of the devices for scheming the unintentional value with fuzzy logic. In [8] illustrated the swarm optimization to discover suitable location of cluster head (CH) with the aim of decreasing the complete energy ingesting throughout packet transmission to descend. PSO is a method which is recognized for its informal execution and quick convergence.

In this paper, LEACH-ERE algorithm is proposed and is used to select the Leader Node on WSN. The predictable/projected residual energy is cast-off in leader node selection for WSNs are also estimated. PSO based fuzzy method is proposed to elect a super leader node (SLN). The rules of fuzzy approach are gets optimized using PSO algorithm.

II. RELATED WORKS

[17]Sengamala Barani.S, Shantha Visalakshi.U, Proposed a fuzzy logic with LEACH protocol , which take energy level, space and device mass as a design thought. (2017)

[18]Xia, H., Zhang, R. H., Yu, J., & Pan, Z. K, Proposed a new power efficient clustering algorithm for inter cluster routing, which provides the load balancing between the multiple cluster heads. (2016)

[19]Moazam Bidaki, Seyed Reza Kamel Tabbakh, Present a scheme, which modify the probabilistic cluster head selection process and present a non-probabilistic approach which creates more symmetric clusters. (2016)

[20]Ying Gao,Chris Hadri Wkram.Jiajie Duan,Jarong Chou, The proposed algorithm implements leader node selection according to the grade of energy attenuation during the network's operation and the grade of candidate nodes efficient exposure on the whole network. (2015)

[21]Madhusudhanan Baskaran,Chitra Sadagopan, Designed to improve the network performance using the light of fireflies. In this method, a tale health function in view of energy, end to end delay, and packet loss rate was proposed (2015).

III. LEACH

LEACH [9][10] is a clustering protocol. In this protocol a leader is chosen among a set of node randomly and that node is then called to be Leader Node (LN). If each node sends the data to sink then maximum of network energy gets wasted for transmission so to overcome this overhead a node is chosen as a leader and all other node transmit their data to head (LN) and this reduces the energy load of the network. Few main feature of LEACH are compression of data before sending it to sink node. Random selection of leader node and most important is to maintain a co-ordination between non LN nodes and LN node.

LN is chosen to the node which powerful than other node in every aspect because LN is the node which needs to communicate with all other normal nodes in the group which are placed distant in the group. LEACH is a protocol which changes the LN periodically because energy of leader node becomes low while communicating with other nodes after one round so replacement of LN is done for the next round. Task of LN is to compress the data collected by normal nodes of the same group and send that aggregate data to the sink node or base station. Data gathering is centralized and from time to time. However the problem is data is not needed from time to time and a lot of energy is wasted due to unnecessary data. LEACH [9] performs in two phases 1) Setup state and 2) steady state.

Setup state: Selection of leader node which is random in case of LEACH is under the setup phase. A fixed fraction of nodes i.e. p is needed to select leader among themselves only. Each node in cluster selects a random number between 0 and 1 and a threshold a selected i.e. T(n). If random number is below, a T(n) then the node become the leader node for that round Except threshold a node must satisfy one more condition to become cluster head. The condition is that node was not acted as leader in last (1/p) rounds. If a node satisfies both the conditions then the probability of becoming LN for that node become high.

The threshold value is given by equation,

$$T(n)=\begin{cases}\dfrac{f}{1-f*(r \bmod 1/f)} & if\ n\in G\\ 0 & otherwise\end{cases} \quad (1)$$

Where,

G: Group of nodes participated for LN election

T(n):Calculated threshold value

f: Fraction of nodes

r: Current round

After the selection of LNs for each group, LNs broadcast advertisement to all non leader nodes LN uses CSMA protocol to transmit the announcement message to all devices in the same group and based on the signal strength normal node joins the cluster and send an acknowledgement message to LN. Steady state: In this phase all nodes transmits the data and leader combined the collected data and then send it to sink node after that round gets finished and then again for the next round setup and steady state starts.

IV. PARTICLE SWARM OPTIMIZATION

Particle Swarm Optimization (PSO) is a sort of looking calculation that was created by Dr. Eberhart and Dr. Kennedy in 1995 [57] and propelled by social conduct of winged creature rushing or fish tutoring.

The basic PSO contain a swarm of S particles (potential arrangements), which through a D-dimensional dilemma pursuit space looking for the ecumenical ideal position that causes the best wellness of a target work [16].

In each hunt space, every hub (molecule) manages its speed to pursue two best arrangements. The first is the intellectual part, where the hub pursues its very own most prominent arrangement found up until this point. After calculate the two best values, node i then updates both its position and velocity iteratively with the following equations:

$$V_{id}(t+1) = w*v_{id}(t) + a_1*r_1*(p_{besti(t)} - x_{id}(t)) + a2*r2*(g_{best(t)} - x_{id}(t)) \quad (2)$$

$$x_{id}(t+1) = x_{id}(t) + v_{id}(t+1) \quad (3)$$

The parameters, a1 and a2 are two positive constants named as learning factors, typically set as a1 = a2 = a3 = 2. r1 and r2 are arbitrary factors between [0; 1]. w is a weight factor that controls the speed of the molecule.

The proposed system, contains the phases such as

- Cluster Formation
- Cluster Head Selection
- Super Head Selection

V. CLUSTERING FORMATION

5.1 System Requirement

1. All the nodes are stale separated from the sink.
2. The sink is movable.
3. In Heterogeneous networks, all the sensor devices have preparatory indistinguishable battery energy.

4. The space among the node and the sink can be calculated grounded on established signal strength.

In heterogeneous sensor systems, characteristically, a huge amount of low-priced nodes achieve sensing, although a uncommon nodes having moderately added energy accomplish data filtering, fusion and transport. This chiefs to the investigation on heterogeneous networks where two or added kinds of nodes are measured. Heterogeneity in WSNs can be pushed off to expand the life time and constancy of the framework. Heterogeneous sensor networks are prevalent, chiefly in real distributions as labeled [10] [11].

EEPCA gets informed of the mutual distance between nodes through broadcasting in the initial stage of nodes grouping. It regulates battery power issue by associating the battery power of a node with the battery power of other nodes surrounded by the communication assortment and regulates distance issue rendering to the proportion of the usual energy used up in one communication outside all devices and the model usual energy ingesting subsequently the node converts the leader node [12].

In view of the vicissitudes in networks situation and mistakes amongst intended and definite node battery power ingesting, set the nodes do not essential to transmission their energy data if the alteration amongst the node remaining energy in the preliminary phase at the present round and the predicted value at the last round is within a certain range[13]. The networks achieve the job of surrounding observing and nodes observer a diversity of things.

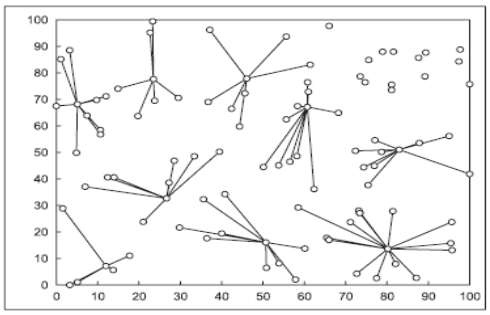

Figure 1: Group formation

5.2 EEPCA Grouping Algorithm

Step1: Calculation of Distance between Nodes and Residual battery power of the entire node

Step2: Leader Node Selection

Step3: Energy Consumption Prediction Mechanism

EEPCA gets informed of the mutual distance between nodes through broadcasting in the initial stage of group formation.EEPCA finds device power factor by match up to the energy of a node with the average energy of other devices within the communication range. EEPCA decides node vitality factor by contrasting the vitality of a node and the normal vitality of different nodes inside the correspondence range.

The probability for nodes to become leader nodes is directly related to energy factor and communication cost factor. The likelihood for nodes to wind up leader node is specifically identified with vitality factor and correspondence cost factor.

Each node will maintain a routing table, which contains node ID, distance between the nodes.

Setup Phase

- Nodes broadcast the transmission signal to all the nodes
- Based on the transmission and receiving signal, the node can calculate the power of the device and communication cost of the node
- In light of the transmission and getting signal, the node can ascertain the vitality of the node and separation of the node
- The highest energy of the device will be elected as a leader node of the cluster
- The leader node send the invites message to all the neighbor node and the neighbor node will send the join message to the nearest leader node

Steady Phase

- The leader node create a schedule for each group member using TDMA fashion
- All the member nodes sends the data to the leader node
- The leader node combined the data and send to the sink as a single packet

5.3 Leader Node Selection

This anticipated research is established the enhanced LEACH-ERE procedure to enhance the energy of WSN grounded energy prediction examination. It is presented a novel donated procedure that protects energy by means of LEACH-ERE, with roughly other assistances. In this research an enhanced protocol had calculated and executed for WSNs that enhance energy indulgence, PDR, delay and lengthened lifetime.

It is cast-off to upsurges the energy saving and lifetime than prevailing energy effectual protocols.It offers an improved LN selection system grounded on energy prediction method.It is castoff to upsurge constancy epoch of the system which outcomes in decent output.

The suggested LEACH-ERE etiquette is a heterogeneous grouping method, in which all wireless sensor nodes can choose whether to be a LN or not self-sufficiently. In LEACH all sensor nodes are qualified for LN selection procedure those have energy superior than zero, but in anticipated protocol predicted residual energy is measured which designate whether a node after execution as a LN can route a round positively or not. It progresses the stable area of the sensor network in which the whole nodes are alive.

ERE Leader node selection Algorithm

Input:

N: a network

a: a node of N

e: Energy

T: a threshold value to become a LN candidate chance(a): a suitability value of the node a to be a LN

k: the number of groups

r: the number of times to be a LN

output:
LN (a): the Leader Node of the node a
isLN(a): true if LN(a)=a
Function:
Broadcast (packet, distance)
Send (data, destination)
Receive (data, source)
LEACH-ERE (Eresidual, EexpResidual)
Initialization
EexpConsumed(l,d,n) = Nframes x (ETx(l,d)+ n x RRx(l))
EexpResidual(l,d,n) = EResidual – EexpConsumed
IsLN (a) = false;
rß0
Function
For each grouping round
If(r==(size(N)/k) then
the node is not eligible for cluster head
set ‘ T ‘ value as 1
Else
Calculate ‘ T ’ value
End if
“Node randomly choose value between 0 and 1”
If (rand(0, 1) > T)
LN (a)ß a;
Calculate Expected Residual energy
Broadcast message
While Receiving message from LN
If Candidate nodes energy level< neighbour nodes energy level
then Candidate nodes is not suitable for
Leader Node
Else if
Candidate nodes energy level> neighbour
nodes energy level
then Candidate nodes is elected as a Leader
Node
Else
Candidate nodes energy level = neighbour nodes energy level
Then compute the communication cost of device node to all devices.
for a = 1 to n do
for b = 1 to n do
dab = distance from sa to sb
End for
End for
Compute the total of all communication cost from one to all devices.
for a = 1 to n do
for b = 1 to n do
Da = Da + dab
End for
End for
Select the LN which has minimum distance and corresponding node will selected as LN
if (isLeaderNode(a) = true)
broadcast(LN-Message)
receive and REQ message
r• r+1
else receive LN message
send REQ message to the closest LN
end if
Super Leader Node(SLN) Selection

The super leader node will be a node from selected leader nodes which will be at an ideal separation, device lifetime, less delay, high packet delivery ratio, greater bandwidth and energy deliberation from the base station.

- In this manner by super grouping we might be total the length of a definitive passed on message yet by methods for just a single node for conveying to the base station an apportion of vitality is ensured, since separation factor is abbreviated.
- The SLN is grounded on

$$E_{TX} = E_{elec} * k + \varepsilon_{amp} * k * d^2$$

$$E_{TX} = E_{elec} * k + \varepsilon_{amp} * k * d^2$$

- Objective Function

$$T_C = W_1 * D + W_2 * E_f$$

Where, D = Total of the distances of all the Leader nodes with each other

Ef = Power required in a transmission to sink from this Leader node - Current energy of this Leader node

W1, W2 = Weight factors that decide the transmission reviewing

Particle Swarm Optimization

- PSO has very few parameters to adjust and has proved to be an effective technique on improving the energy of the node.
- In each time step, a molecule needs to move to another position. By modifying its speed utilizing the accompanying parameters.
- The present location,
- The present directions,
- The distance between the present position and pBest,
- The distance between the present position and the gBest.
- PSO is introduced with a gathering of arbitrary particles (arrangements) and after that looks for ideal by refreshing ages.
- Particles travel through the arrangement space and assessed by some wellness foundation after each time step. In every cycle, each molecule is refreshed by utilizing two "best" values.
- The first is the best arrangement (wellness) it has accomplished up until this point, pBest.

- Next "best" esteem that is followed by the molecule swarm analyzer is the best esteem acquired so far by any molecule in the populace. It is a worldwide best, gBest. After finding the two best values, the particle updates its velocity and positions with the following equation

v' = v + c1.r1.(pBest - x) + c2.r2.(gBest – x)

x' = x + v‘ à(1)

Where v is the current velocity

v' is the new velocity

x is the current position,

x' is the new position

r1 and r2 are even distributed random numbers in the interval [0, 1]

c1 and c2 are acceleration coefficients.

Particle Swarm Optimization (PSO) Process

1. Instate every molecule with an irregular speed and arbitrary position.

2. Compute the expense for every molecule. On the off chance that the present expense is lower than the best esteem up until now, recall this position (pBest).

3. Pick the molecule with the most reduced expense everything being equal. The situation of this molecule is gBest.

4. Figure, for every molecule, the new speed and position as indicated by the condition (1).

5. Repeat steps 2-4 until target is attained.

Compute Objective Function

1) l1 =l2 = 1 For any two leader nodes LeaderNode1 and LeaderNode2 let (D, E) pairs be (2, -3) and (4, -6) respectively

Let, Tc = l1*D + l2*E

LeaderNode1: 1*2 + 1 *(-3) = -1

LeaderNode 2: 1*4 + 1 *(-6) = -2 (Elected)

In the above case LeaderNode2 gets chose as the super leader node because of its lesser Tc esteem. Note that sign is thought about.

2) Now, let us consider l1= 8, l2= 3

LeaderNode 1: 8*1 + 3* (-2) = 2 (Elected)

LeaderNode 2: 8*2 + 3* (-4) = 4

- Now, LeaderNode1 gets elected due to the l1 consideration.

- Since the total of entomb LeaderNode separations is more noteworthy in LeaderNode2 than in LeaderNode1 hence to limit the vitality dispersed in the system we choose LeaderNode1 as the SCH.

3) Again let, l1=3 and l2=8

LeaderNode 1: 3*1 + 8*(-2) = -13

LeaderNode 2: 3*2 + 8*(-4) = -26 (Elected)

- Now, LeaderNode2 gets elected as the SCH due to l2 consideration.

- Since the power required in the transmission is less in LeaderNode2 than in LeaderNode1.

5.5 RESULTS AND DISCUSSIONS

End to end delay Vs Number of nodes:

When node gets increased, the performance of LEACH gets decreased and the performance of, EEPCA, LEACHERE and LEACHERE_PSO value gets minute changes. In this result, LEACHERE_PSOis better than EEPCA, LEACHERE and LEACH.

Table 1: End to end delay Vs No of nodes

Nodes	EEPCA	LEACH	LEACHERE	LEACHERE_PSO
20	2.22	2.5	1.68	1.65
30	2.2	2.45	1.6	1.35
40	2.12	2.42	1.5	1.3
50	1.9	2.4	1.45	1.25
60	1.84	2.2	1.36	1.28
70	1.7	2.24	1.52	1.15
80	1.75	2.15	1.35	1.25
90	1.6	2.3	1.3	1.2
100	1.62	2.3	1.17	1.1

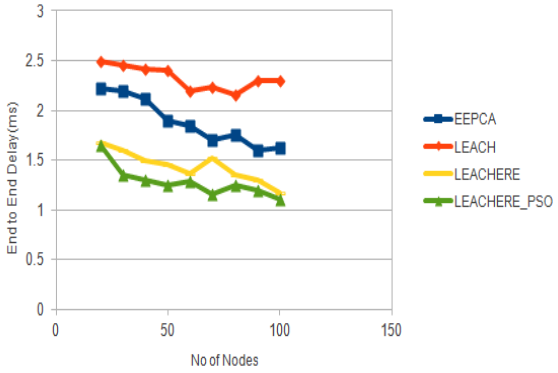

Figure 6: End to end delay Vs No of nodes

Lifetime Vs Number of nodes:

When node gets increased, the performance of LEACHERE_PSO gets increased and the performance of EEPCA value gets increased, LEACHERE value gets increased and LEACH value gets minute changes. In this result, LEACHERE_PSO is better than EEPCA, LEACH AND LEACHERE.

Table 2: Lifetime Vs No of nodes

Nodes	EEPCA	LEACH	LEACHERE	LEACHERE_PSO
20	32.604	31.2	33.46	34.284
30	32.567	31.14	33.52	34.336
40	32.7	31.098	33.4	34.386
50	32.8	31.3	33.34	34.26
60	32.7	31.35	33.68	34.325
70	32.3	31.34	33.72	34.347
80	32.304	31.478	33.38	34.367
90	32.843	31.678	33.23	34.395
100	32.69	31.302	33.46	34.661

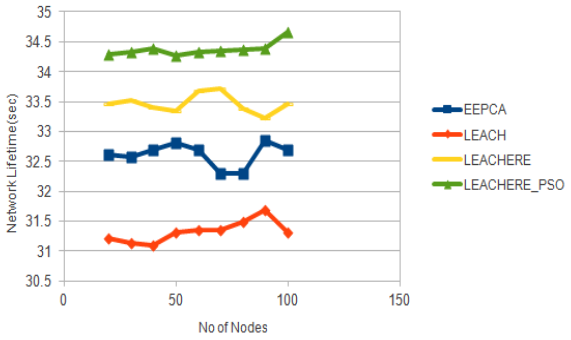

Figure 7: Lifetime Vs No of nodes

PDR Vs Number of nodes:

When node gets increased, the performance of LEACHERE_PSO gets increased and the performance of LEACH, LEACHERE and EEPCA value gets increased. In this result, LEACHERE_PSO is better than EEPCA, LEACH and LEACHERE.

Table 4 PDR Vs No of nodes

Nodes	EEPCA	LEACH	LEACHERE	LEACHERE_PSO
20	44.67	43.67	50.67	55.67
30	48.56	47.87	55.45	59.76
40	53.67	53.87	58.96	62.78
50	55.78	55.75	60.45	65.45
60	59.75	55.75	60.75	65.75
70	64.67	57.56	62.56	69.57
80	69.34	60.57	72.45	75.78
90	75.45	70.36	79.67	85.46
100	82.06	75.06	85.06	89.06

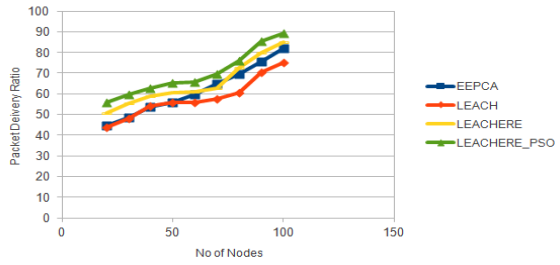

Figure 9: Packet delivery ratio Vs No of nodes

5.6 CONCLUSION& FUTURE ENHANCEMENT

In this paper, HWSN is anticipated EEPCA for efficient communication along with better network performance. The existing system has issue with grouping formation and leader node selection. To avoid these problems, the proposed research introduced EEPCA for handling clustering formation in HWSN, LEACH-ERE protocol for LN selection and PSO based fuzzy approach for SLN. Thus the proposed research has three modules and they are: (1) Grouping formation using EEPCA in HWSN, (2) LN selection by using LEACH-ERE, (3) SLN using PSO based fuzzy approach. EEPCA approach is to protect energy ingestion when nodes transmission in primary grouping stage of every round, an energy forecast replica of nodes is recognized. Then, LN is selected by using LEACH-ERE protocol which selects the nodes highest energy level of sensor nodes and bandwidth. It has efficiency for transmitting rapidly the required information in the given network. Then apply the PSO algorithm for selecting the SLN along with fuzzy rules. This approach is very useful to choose the superior nodes among several nodes. It has capability to manage scalable HWSN which leads network performance higher. Thus the proposed LEACH-ERE with PSO_Fuzzy approach provides higher PDR, bandwidth, network lifetime, throughput and lower in energy consumption and delay. Hence this research concludes that the proposed LEACH-ERE with PSO_Fuzzy approach has robust network performance compare than previous LEACH and LEACH based fuzzy approach. Still this research has issue with attack detection and hence it can be extend to be future work.

VI. PROCEDURE FOR PAPER SUBMISSION

A. Submission of the paper

Author (s) can send paper in the given email address of the journal. There are two email address. It is compulsory to send paper in both email address.

VII. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

It is optional. The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ... .” Instead, write “F. A. Author thanks ” *Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page*.

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