HYBRID OPTIMIZATION IN WIRELESS SENSOR NETWORKS TO IMPROVE NETWORK LIFETIME

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ABSTRACT:

Wireless Sensor Networks (WSNs) contains lot of sensor nodes which are used for networking. These are connected through wireless medium, which work to collect physical information from the environment. The sensor nodes are operated through a battery, but the battery is lost the power after some time. In this way, battery energy plays an important role in the WSNs lifespan. The objective of this work is to improve the lifetime of the wireless sensor networks. Many swarm intelligence techniques have been used in existing research to improve the network's life time. There are a lot of drawbacks inside existing techniques such as week routing, slow convergence, improper balancing between exploitation and exploration phases. Hybrid ACO algorithm is used for optimal path selection. This proposed algorithm is integration of ACO and PSO. The performance analysis of proposed algorithm has been done on the basis of alive nodes, remaining energy. The performance of proposed work has compared with CRHS, BER, CPSO, ALOC, FLION and BOAACO. The residual energy and alive nodes are higher in the proposed algorithm.

Keywords : Wireless Sensor Network, Butterfly optimization, Ant Colony Optimization and Particle Swarm Optimization

I. INTRODUCTION

Wireless Sensor Networks (WSN), contains more than one sensor nodes. These nodes record values on regular basis. These values are shared in the company of sink node. These values are transmitted by means of node to node transmission and CHs. Information’s are transmitted in the direction of CH nodes by sensor node. This information is further forwarded to BS for further communication [1, 2]. Overall picture of Wireless Sensor Networks is illustrated in figure one. It has been clearly noticed from this figure that sensing device, CHs and another intelligent mechanics transmitted information in the direction of sink node or information server. Nowadays WSN applications are utilizing in a lot of areas like, Environmental monitoring, Health monitoring, Animal tracking, Military tracking [2,3], traffic analysis, remote sensing, forests monitoring, monitoring underwater (3-D) three-dimensional environment and also monitoring in civil occupation etc [4]. The sensor nodes send, receive, acknowledge the information & also configure the association through its neighbour nodes or sink nodes [5]. These are (sensor nodes) managed by power driven batteries and these are non-expendable & non-chargeable. In these circumstances the energy efficiency is most important in all sensors nodes for their better functionalities [6]. It is needed to improve the lifetime of sensor nodes’ in WSNs because the use of this network is not available most of the time [7]. A lot of studies have been covered by various scholars in energy optimization techniques but still it is an open challenge to construct suitable energy optimized techniques for sensor nodes in Wireless Sensor network’s. At the time of this transmission, effective transmission becomes a major problem. In outer regions where nodes are implemented with the help of small aircrafts, after the activation of sensor nodes batteries in the crucial settings it becomes very difficult to replace them. The task of transmission becomes more difficult in those situations where more than one node become inactive because of excessive power usage [8].

Transmission protocols are established on the basis of those protocols which depend upon chain of command, flexibility, movement, place, information center, more than one path, diversity and quality of service.
Arrangement of transmission protocols is established on the basis of grouping. Chain of command dependent protocols are the protocols which are established on the basis of TEEN, APTEEN, HEED, PEGASIS and LEACH. Transmission protocols which have been associated in the company of wireless sensor networks are established on the basis of those protocols which depend upon chain of command, flexibility, movement, place, information center, more than one path, diversity and Quality of service. For the identification of method which can consume energy in a very effective way the present data transmission protocols are examined by us in a very careful manner. Power consumption becomes a difficult part of dissertation when packets are transmitted with the help of those networks which is not reliable. For the purpose of energy usage more than one method are already submitted. At the same time, grouping transmission protocols exist in the form of protocols which are highly reliable. They are utilized for the purpose of power consumption, balancing of load, transmission cost and for the transmission of packets in the direction of base station [9]. For the management of power consumption in wireless sensor networks lots of research work has been done already within wireless sensor networks number of transmission protocols is implemented in order to use energy i.e. ECBRP has been utilized for the transmission of information in the direction of base station and for consuming energy. Most part of information has been created with the help of sensor nodes where heavy traffic load create collision. Differences in the middle of sensor nodes become moderate when the transmission is done with the help of more than one channel. Energy effective hybrid ED [10] is bring in to use for making the consumption of energy effective and for tackling the quantity of data. Inside the wireless sensor networks each and every type of modification is identified with the help of reality. The methods which have been submitted in the past are mostly utilized for the identification of complex event [11, 12] in support of energy usage previous assessment are principally done by taking the usage of energy in to consideration.

Remaining sections are separated in following manner: The second section introduces literature review. Proposed Hybrid Ant colony optimization is represented in section-3. The section-4 represents the optimal route selection on the bases of Hybrid ACO. The last section describes the future work.

II. LITERATURE REVIEW

Inside the wireless sensor network consumption of energy becomes very significant. Lots of methods are already submitted for the consumption of energy. But, at the same time, neither of them is considered efficient. For addressing problems like balancing of load, communication cost and energy usage number of transmission algorithms are offered [13]. Review of written material is done on the basis of routing which has been established on the basis of chain of command. Large number of transmission protocols is used inside the wireless sensor
networks. Some of them are belongs to a specified family of protocol. The basic reason behind the use of such type of protocol is to consume the energy in an effective manner and for maximizing the network life-span. Protocols which are formed on the basis of group and some other power consumption protocols are mainly designed in support of wireless sensor networks. Inside the wireless sensor networks, protocols which are formed on the basis of group required that energy should be used in an effective way. By keeping the prospective of safety, flexibility, size, and price in mind, sensor nodes are designed in the wireless sensor networks [14]. From the last many years, number of methods is submitted in relation to those transmission protocols which are formed on the basis of grouping. Sensor nodes of CH transmit those sensed information which are related to similar group. Two data groups are removed by CH for tackling the concluding packet and for the combination of data out of various measurements. From this consumption of power and network life span become better. S-SEECH protocol which is introduced in support of wireless sensor networks becomes the method by which it has been described that the distance in the middle of group and sink node is very large. According to the aspects of security authentication, availability, confidentiality and integrity of services are available [15]. The basic purpose behind the use of coding and short hand technique is safe. Inside the wireless sensor networks number of attacks comes in to existence in connection with safety transmission device. Attacks like Daniel of service, Sybil attacks, black hole and some other are come under the category of most dangerous attacks. Inside the wireless sensor networks for improving safety efficiency and for minimizing energy usage keys are employed [16]. Inside the wireless sensor networks for improving the effectiveness of energy consumption MAC protocol is bring in to use. By this time it is used in wireless sensor networks, but at the same time none of the protocol is accepted in the form of individual standard [17]. For improving network life span and for improving its efficiency Holistic method is bring in to use. In order to verify safety it takes each and every network layer in to consideration [18]. It will offer safety to each and every network layer. The explanation of safety on an individual layer fails to become the effective explanation. Holistic method becomes the good solution [19]. Its main weakness is the time which it takes for the execution of difficult calculations [20]. In relation to power consumption DEC and SEP becomes the highly significant group based protocols. Inside the wireless sensor networks consumption of energy in a limited amount becomes the most significant problem. For effecting network life span, battery power and nodes which are associated in the company of ineffective energy becomes inactive in a rapid manner. It becomes possible to use energy in an improved manner by reducing packets conjugation. In the Wireless sensor networks contains like and unlike network. By keeping hardware and consumption of energy perspective in mind organization of sensor nodes are done inside the wireless sensor networks. In unlike network additional treatment and other vitality make the network life span better. In comparison to sensor node the cost of additional battery becomes poor. Because of heavy traffic reasons nodes become inactive in a very quick way in situations where they surrounding the sink [21]. In support of grouping methods which has two stages SEP protocol becomes dynamic. Data is transmitted by sensor nodes when the network becomes active. In support of grouping methods which has two stages SEP protocol becomes dynamic. SEP exist in the form of protocol in which more than one stage of unlikeness is introduced inside the wireless sensor networks [22]. In comparison to usual nodes, extra power is distributed in the direction of improved nodes. SEP protocols are formed on the basis of sensors and usual energy growth. Such types of protocol possess two perfect weights. One in support of usual node and another for improved node. Such type of protocol improved the consumption of power and network life span by means of improved nodes. Heterogeneity protocols are of three levels in SEP protocol [23] in this protocol to control the loss of energy with three level of heterogeneity. Additional transmission protocol which has been used for improving energy usage, constancy and network life span is TEEN. In situations where maximum amount of nodes becomes inactive and it becomes impossible to retrieve data out of sensing device, then transmission in the company of CH also become impossible through these nodes. It becomes the main disadvantage of TEEN. For the resolution of such type of issues TSE protocol was submitted on the basis of reactive transmission of that uses three levels of heterogeneity nodes; advance nodes, intermediate nodes and normal nodes. The drawback of SEP protocol is that it does not supports variations in energy consumption [24]. In addition to this, in the middle of usual nodes and improved nodes, the selection of cluster head fails to remain active. This is the reason due to which dead nodes are used initially [25]. In TSEP, for additional amount of energy \( \mu \) is used in support of advanced nodes, and in support of the usual and intermediate nodes \( \mu/2 \) is used for the management of additional space. In the SEP protocol, the energy and lifetime of the network improves by means of improved nodes. Deterministic Energy Effective grouping Protocol (DEE) emerges in the form of that grouping method which is nearly appropriate. Inside the group communication is done either in single step or in multiple steps. In single step communication single message is transmitted in the direction of the single neighbor. In such type of communication energy is improved and consistency reduced [26]. 3-T node is arranged in a two-stage hierarchical structure, and the effect of that work is SEP wait, also known as SEP-E. The primary goal of this
dissertation is to improve the network's life cycle and achieve efficient automation. The Strong Election Protocol (SEP) is based on the use of a sensing system and the normal growth of electricity. A protocol of this kind has two optimum weights, one for the normal node and the other for the advanced node. Each node is determined by DEC based on energy and cluster head selection. Approval of the DEC algorithm is the optimal approach. The DEC model's key benefit is the comprehensive choice to cluster head [27]. Inside the wireless sensor networks, the network life-span, reliability and energy become the most significant parameters. It is a dissertation where a novel grouping method DCHR is proposed by them for the very first time. The full form of this method is Dual cluster head routing protocol. It is a method which came into existence for improving network life span in the company of 3 level of heterogeneity in dual group. For the minimization of energy wastage reduction in cluster accumulation becomes the necessary requirement.

ETARP [28] is the transmission protocol which is formed on the basis of trust. In such type of protocols transmission cost is low. It specifies the route of path on the basis of optimization usage. At the same time, it fails to become energy effective [29]. A novel trust aware energy effective transmission method is submitted by the scholar. The method which has been submitted here makes the network lifetime better and improves the safety of data. In WSN a latest opportunistic method is proposed in a special manner. In the WSN, opportunistic routing is suggested for trust-based energy efficiency simulations to verify parameter accuracy. Opportunistic routing has the disadvantage of containing forward set collection and prioritization [30]. The challenge of selecting the normative co-predictors of the time in the sample characteristics is a concern in forward set selection [31]. The systematic code review of the evaluation units is a disadvantage to prioritization [32]. In order to consume energy number of transmission protocols is implemented inside the wireless sensor networks. For the transmission of data in the direction of base station and for consuming energy EECBRA [4] is bring in to use. Sensor nodes formed the major part of data. Here, a collision is created because of heavy load of traffic. The conflict in the middle of sensor nodes becomes moderate when the transmission is done by means of multiple channels. Energy effective hybrid ED [6] is bring in to use for making the consumption of energy effective and for tackling the quantity of data. Inside the wireless sensor networks each and every type of modification is identified with the help of reality. The methods which have been submitted in the past are mostly utilized for the identification of complex event [6, 7] in support of energy usage Previous assessment are principally done by taking the usage of energy in to consideration. TA is the transmission protocol which is brings in to use for providing safety in opposition to malicious attacks from different point of view. Cost associated in the company of energy, distance in the middle of sink node and its adjacent node and effective transmission is discussed in methods [33–36]. In some positive and negative points, the highly significant point becomes the introduction of that method which offers the energy effective route. Few characteristics of sensor nodes are used for providing trust awareness system in support of malicious attacks safety. The main objective is the selection of perfect route in trust value.

In table four those methods are discussed in an absolute manner by which energy efficient protocols are provided. It has been identified by us there is opening for those energy efficient schemes that can provide dependable solutions. In [37], a comparison was done in the middle of HEER protocol which was established on the basis of group and present day heterogeneity based transmission protocols. Due to the modification in LEACH method which is done by the author of publication [38], its consumption of power becomes better and the inactive nodes reduced by eighty eight percent. For the consumption of energy in an efficient manner in [39], SEP protocol is bringing in to use. The main disadvantage of this protocol is that it fails to maintain energy usage in support of some specific tasks. In table five those methods are discussed in an absolute manner which provides output and criticism in relation to those transmission protocols which has been established on the basis of group from various methods. Here a transmission protocol HEER which was established on the basis of group has been submitted by the author. After that a comparison was done in the middle of this protocol and the protocols which are established on the basis of heterogeneity.

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Effect on power consumption</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAHBRP</td>
<td>For the achievement of power consumption they use Holistic method.</td>
<td>In this dissertation holistic method is used. Its main weakness is the time which it takes for the execution of difficult calculations.</td>
</tr>
<tr>
<td>SCERP</td>
<td>Consumes more energy when it is far away from the BS</td>
<td>Black hole attack.</td>
</tr>
<tr>
<td>EECBRP</td>
<td>In comparison to another present day</td>
<td>Here, node of CH is elected in a</td>
</tr>
</tbody>
</table>

Table 1 Assessment table related to group based transmission protocols:

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protocol energy become highly efficient random manner. At the same time, election of node in a random manner is not secure because it becomes possible that a node is Sybil node

EECBRA In comparison to LEACH protocol the efficiency of this algorithm is four energy joule Multiple channel attenuation becomes the main weakness

EEKCP It has been demonstrated by outputs that the energy of submitted method is good The drawback of k-mean is that it only changes the symmetrical data and k means accepts to deal with a circular clusters and that each cluster has randomly equal numbers of opinions

SEP-E It is a protocol in which energy improves up to thirty percent SEP protocol fails to maintain alternation in energy usage

MHR It nearly use eighty five percent energy Use of similar links which fails to provide unwanted mathematical signals. Additional weakness is the transmission of key before the transmission of original information

DHCR protocol Energy consumption is improved up to ten percent Black hole attack, Fabrication attack

CH-Leach Energy consumption is increased up to eighty five percent. It is assumed by k-means that variance of each and every variable is similar and it is spread in circular form. If one of them miss, then the k mean fails Sybil attack

REEHCBR protocol In comparison to existing it is nearly hundred percent better Black hole attack

ILA Expired nodes reduced up to eighty eight percent with the help of better methods Black hole attack

E2HRCRA In comparison to real RPL the method is one point seven percent better Here, node of CH is elected in a random manner. At the same time, election of node in a random manner is not secure because it becomes possible that a node is Sybil node

III. PROPOSED HYBRID ANT COLONY OPTIMIZATION

Ant colony optimization algorithm (ACO) has been considered probabilistic mechanism to solve computational issues. These issues could be reduced by finding good paths through graphs. Artificial ants stand for multi-agent methods inspired by the behavior of real ants. In proposed research ACO has been used to find the good paths. In proposed research ACO has been used to find the good paths. On other hand PSO is particle swarm optimization that is used to find the best solution among multiple solutions. In proposed work the ACO and PSO mechanism are integrated. Here ACO is playing significant role in finding good paths whereas PSO has been used to find the optimized path.

The working of PSO with integration of ACO presented in following flowchart where routes found using ACO are considered as initial particles and the PSO is calculating the fitness of every path for each generation. The fitness is presenting the suitability of particular path according to distance, congestion and quality of path. The personal best of routes would be updated and the mean best is found afterward. Finally the global best is calculated to update the position of selected path. If convergence is performed then iteration is stopped otherwise the iteration keep finding the fitness of each path.
Figure 2. Process flow of ACOPSO integrated route selection mechanism

Algorithm of Hybrid ACOPSO

1. Chose the base station BS and cluster head CH
2. Consider the several factors such as distance, congestion, quality of path that are influencing factor used by ACO to choose good path
3. Generate good paths using ACO
4. Find the fitness of each route (path)
5. Update the personal best of every route
6. Find the mean best
7. Updated the global best route
8. Update the rank of every route
9. If conversed then stop otherwise
   a. Increment in Gen by one
   b. Move to step 4
Figure 3. Flowchart presenting the role of PSO in optimized selection of routes chosen by ACO

3. Comparative analysis of the proposed methodology with other cluster based routing algorithms

The performance of proposed work is compared to previous cluster dependent routing mechanism in order to check out effectiveness of proposed work. Previous mechanisms have been kept in mind during evaluation of proposed work. These mechanisms are CRHS [40], BERA [41], CPSO [42], ALOC [43], FLION [44] and BOAACO [45]. Results have been obtained by comparing all these mechanisms in various scenarios are shown below:

**Scenario A:** Here 200 sensors have been deployed in sensing area of 200×200m². Base station has been situated at (250, 250). Scenario A is performing comparison of proposed methodology with CRHS and BERA and BOAACO. Proposed work is found approximately 1.003 times better in BOAACO

**Scenario B:** Here 100 sensors are deployed in the sensing area of 100×100m². In this case, the BS is located at (0, 0). Scenario B is performing comparison of proposed methodology with ALOC and BOAACO. In this scenario proposed work is found 1.006 times better then BOAACO

**Scenario C:** Here 100 sensors are deployed in sensing area of 100×100m². Base station is located at (50, 50). Scenario C is performing comparison of proposed methodology with FLION and BOAACO.

Table 2: Comparative analysis of residual energy for proposed methodology with existing routing algorithms

<table>
<thead>
<tr>
<th></th>
<th>Scenario A</th>
<th></th>
<th>Scenario B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRHS</td>
<td>BERA</td>
<td>BOAACO</td>
<td>Proposed work</td>
</tr>
<tr>
<td>200</td>
<td>230.1352</td>
<td>350</td>
<td>388.1296</td>
<td>389.294</td>
</tr>
<tr>
<td>400</td>
<td>140.3814</td>
<td>290</td>
<td>377.2473</td>
<td>378.379</td>
</tr>
<tr>
<td>600</td>
<td>89.2002</td>
<td>250</td>
<td>365.7348</td>
<td>366.832</td>
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<tr>
<td>Number of Rounds</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----</td>
<td>------</td>
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<td>------</td>
</tr>
<tr>
<td>Residual Energy</td>
<td>57.4633</td>
<td>34.6276</td>
<td>24.6593</td>
<td>18.5922</td>
</tr>
<tr>
<td>200</td>
<td>354.5350</td>
<td>343.7332</td>
<td>332.4183</td>
<td>320.1775</td>
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<tr>
<td>355.5986</td>
<td>344.7644</td>
<td>333.4156</td>
<td>321.138</td>
<td>315.7244</td>
</tr>
<tr>
<td>30</td>
<td>35.0420</td>
<td>31.3138</td>
<td>27.5431</td>
<td>23.8564</td>
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<tr>
<td>27</td>
<td>31.5016</td>
<td>27.70836</td>
<td>23.99954</td>
<td>22.0474</td>
</tr>
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</table>

**Figure 4.** Comparative analysis of residual energy for Scenario A

**Figure 5.** Comparative analysis of residual energy for Scenario B
Table 3. Comparative analysis of alive nodes for proposed methodology with existing routing algorithms

<table>
<thead>
<tr>
<th>Rounds</th>
<th>Scenario A</th>
<th></th>
<th>Scenario B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRH S</td>
<td>BER A</td>
<td>BOAACO</td>
<td>Proposed work</td>
</tr>
<tr>
<td>200</td>
<td>129</td>
<td>160</td>
<td>200</td>
<td>200</td>
</tr>
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<td>400</td>
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<tr>
<td>2500</td>
<td>-</td>
<td>-</td>
<td>152</td>
<td>187</td>
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</tbody>
</table>

Figure 6. Alive nodes for Scenario A

Figure 7. Alive Nodes for Scenario B
Table 7. Comparative analysis of proposed methodology with FLION for scenario C

<table>
<thead>
<tr>
<th>Rounds</th>
<th>Alive nodes</th>
<th>Average energy consumption (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FLION</td>
<td>BOAACO</td>
</tr>
<tr>
<td>500</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1000</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>1500</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>2000</td>
<td>38</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 8. Comparison of Alive nodes for scenario C

Figure 9. Comparison of Average energy consumption (J) for scenario C

IV. CONCLUSIONS

Wireless Sensor Networks (WSN), contains more than one sensor nodes. These nodes record values on regular basis. The sensor nodes are operated through a battery, but the battery is lost the power after some time. In this
way, battery energy plays an important role in the WSNs lifespan. Hybrid ACO algorithm is uses for optimal path selection. This proposed algorithm is integration of ACO and PSO. The performance analysis of proposed algorithm has been done on the basis of alive nodes, remaining energy. The performance of proposed work has compared with CRHS [40], BERA [41], CPSO [42], ALOC [43], FLION [44] and BOAACO [45]. The residual energy and alive nodes are higher in the proposed algorithm. The proposed work has introduced optimal routing, fast convergence, proper balancing between exploitation and exploration phases.

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