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AN IMPROVED ENERGY EFFICIENT ROUTE OPTIMIZATION TECHNIQUE USING CUCKOO SEARCH

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Abstract: In energy-limited WSNs, coverage and connectivity are two of the most fundamental QoS issues, which have a great impact on the performance of WSNs for minimizing the node energy consumption and maximizing the network coverage lifetime. Due to the node distribution, the energy consumption among nodes is more imbalanced in cluster-based WSNs. In the existing system, Sink Mobility based Energy Balancing Unequal Clustering protocol (SMEBUC) for WSNs with node distribution, which chooses the nodes with more energy as cluster heads and divides all nodes into clusters of different size through the improved Shuffled Frog Leaping Algorithm (SFLA). To reduce the cluster head replacement frequency, cluster head serves continuously to determine the cluster head exchange time and nodes weight. The greedy algorithm is adopted to select the optimal relay node between cluster head and Sink. But still some issues are arising in the optimal route discovery. These issues are resolved in this work by introducing the novel framework for the route establishment namely Reliability aware energy and trust based routing protocol (RETRP). At the time of route establishment, reliability of the nodes also considered with the trust and energy consumption factor. In the proposed research work, cuckoo search Algorithm is used for trust and reliability aware route establishment. After route establishment, worm whole attacks are discovered using expected packet transmission count value.

Keywords: *Cuckoo Search, Energy, Optimization, Fitness*

I. INTRODUCTION

The name of Wireless Sensor Networks (WSN) is Wireless Sensor and Actuator Networks (WSAN). In this network are circulated to the independent sensor to observe corporal or ecological conditions like sound, pressure and temperature and so on. And also it is used to transfer the data to the corresponding destination by using the network. In present, the networks following the bi-directional model and also manage the sensor movement. The improvement of Wireless Sensor Network is provoked by armed applications for example combat zone observation. In present days, the wireless sensor network is used in more number of applications like apparatus health monitoring and manufacturing process monitoring and control.

Due to the small size of a sensor node, lifetime, communication capabilities, processing ability and memory are constraint of the WSNs. Therefore, a more effective topology control protocol to prolong the lifetime, efficient energy consumption and to improve coverage and the payload balance is one of the key factors in WSN design. Since sensors are often deployed in remote or inaccessible environments where replenishing the sensor energy is usually impossible, a critical issue of WSN is conserving sensor energy and prolonging the network lifetime while guaranteeing the coverage of desired areas or targets, which is called the coverage problem [4]. The coverage concept is subject to a wide range of interpretations due to the variety of sensors and applications. Generally, coverage which has direct effect on the network performance can be considered as the measure of Quality of Service (QoS) in a WSN. The increasing demand for applications in WSN has made the QoS an

interesting and hot research topic. QoS requirements of WSN raise the significant challenges. While providing QoS guarantee, the network protocols need to deal with energy constraints. With the consideration of the properties of sensor networks such as limited energy, dynamic topology, high network density and large scale deployments have posed many challenges in the design, implement, and management of WSN. These challenges have demanded energy awareness and robust protocol design at all layers of the network protocol [5].

Now a day, in the wireless communication networks field the topic of trust and statue will be applied to observe the different kind of characters of sensor nodes and counter node unwanted steps. Trust is a novel method to given that the security without the help of cryptography methods [1]. In the wireless communication network field the trust can be described as amount of dependability of another nodes to perform the process [2]. In the trust method, based on the previous information the upcoming process can be predicted and help to take the efficient resolution for identification of suspicious nodes characteristics. Additionally, this trust based methods are appropriately for the security planning of sensor network [3].

Many number of trust based and power constrained secure routing protocol has been introduced by the scientist [4], [5], [6] to counter node fault process. On the other hand, the results cannot be applied to the wireless sensor networks directly owing to the restricted possessions on part of sensor nodes.

In this present work, for the wireless sensor network the new method is developed to give the security and dependable trust based power consumption routing protocols. The following steps are used to get the secured protocol transmission with more dependability, power utilization and trust value for this structure. Cluster head decides the successful transmission of the data points across various data nodes. The optimal cluster head selection is done using the algorithm called the modified genetic algorithm. The constraints considered for the cluster head selection are energy, trust value and its reliability.

Better route establishment is done for performing the successful data transmission which is done in this work using the methodology called the cuckoo search Algorithm which will establish the route where the nodes involved should ensure the high level trust value, reliability and enough energy resource.

After route establishment, the data transmission is secured in run time by preventing the worm whole attack which might lead the data packets to the malicious nodes. This is done via calculating the expected packet transmission count value.

The entire process of this proposed work is given as follows: To get the optimal route establishment by using the different parameter has been conducted in a variety of research work. This process is discussed in Section 2.The overall process is explained in detailed manner in Section 3. The experimental appraisal of the present work is explained in section 4. At last, the conclusion with the advantages and disadvantages of the proposed work is described in detailed manner in section 5.

II. Existing System

We note that in LEACH, each node randomly decides to become a cluster head(CH). Once a node decides to become a cluster head, it aggregates the data received from various nodes inside the cluster and sends to the base station. However, the method of completely independent random cluster head selection can’t guarantee the number nodes in the cluster and the distribution of cluster head in each

round. One possible method is to select a node which has higher remaining energy to become the CH, but it will cause the uneven energy loss for nodes in the network and form monitoring blind spot, even will influence the network's whole performance. In this research, we assume that a set of sensor nodes are unequally deployed in the square field to continuously monitor the phenomenon under inspection. Fig.1 presents the packet transmission from node A to B on WSN.

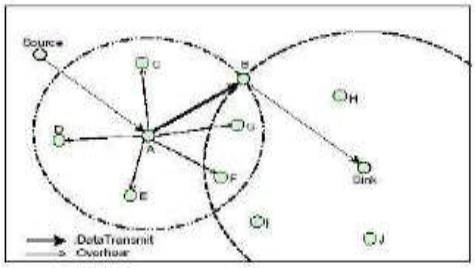


Fig. 1: Packet transmission of WSN

In Fig.1, node A transmits its data packet to B and all nodes within the transmission range can overhear the packet.

2.1 SMEBUC Protocol

Within the monitored region, due to the different distances of the nodes and Sink, the energy consumption of communication is also different that is the greater the distance the greater the consumption of energy. For the balance of energy, the further of the cluster, the size should be larger. And the closer to clusters, the scale is smaller. The energy consumption of the network nodes is more balanced, which is the reason of unequal clustering. SMEBUC uses the method of combining unequal clustering and inter-cluster multi-hop routing. The communication process between cluster head and Sink node consists of two stages which are cluster establishment and data transmission. To further balance the node energy, SMEBUC adopts the cluster head Competition mechanism in the process of clustering, and Sink nodes can move in the default location.

To avoid problem that the reincarnation clustering mechanism consumes large amounts of energy, SMEBUC has a clustering process at network launch time. At the network deployment phase, the Sink node broadcasts a signal in the network with a given transmission power. Once each sensor node receives this signal, it calculates its approximate distance to the Sink node according to the received signal strength. The cluster head is the most important node which does not only manage the cluster members, coordinate the data transmission of the member nodes, but also fuses the data collected by cluster members, and sends the processed data to the Sink node.

Due to the heavy burden of cluster head, we select the node with the higher residual energy as the cluster head at the beginning of each data collection cycle and reconstruct cluster. The cluster head selection rule is that the Sink node knows the location and energy information of all nodes in the network, cluster classification and cluster member determination is completed by Sink node because at the end of each round, the cluster members report their remaining energy to the cluster head, and the cluster head reports the sum of residual energy of all cluster members (including itself) to Sink node. Finally the Sink node calculates the total energy of the entire network, and broadcasts to all nodes. Once the cluster head is determined, the sensor node ni belongs to the cluster head to which is the closest.

III. Proposed System

3.1 Secured Reliable Trust Based Routing

The name of Wireless Sensor Networks (WSN) is Wireless Sensor and Actuator Networks (WSAN). In this network are circulated to the independent sensor to observe corporal or ecological conditions like sound, pressure and temperature and so on. The Routing method is used to choose the greatest path in the wireless sensor network. In the previous method, the routing is used to forwarding network traffic in the middle of the networks. On the other hand, concluding function is improved the forwarding function. Routing process is common for the different types of wireless sensor network such as electronic data networks (internet), transportation network and telephone networks (circuit switching).

This structure performs following actions to achieve the secured transmission of protocols with more reliability, energy consumption and trust value.

Cluster head decides the successful transmission of the data points across various data nodes. The optimal cluster head selection is done using the algorithm called the modified genetic algorithm. The constraints considered for the cluster head selection are energy, trust value and its reliability

Better route establishment is done for performing the successful data transmission which is done in this work using the methodology called the cuckoo search Algorithm which will establish the route where the nodes involved should ensure the high level trust value, reliability and enough energy resource.

After route establishment, the data transmission is secured in run time by preventing the wormhole attack which might lead the data packets to the malicious nodes. This is done via calculating the expected packet transmission count value.

The entire process of secured and reliable data transmission is illustrated in Figure 2 and this process is decreasing the data loss and achieves the packet transmission. In the following subsection, the overall process is described in detail.

The overall flow of the research work is given in the following diagram

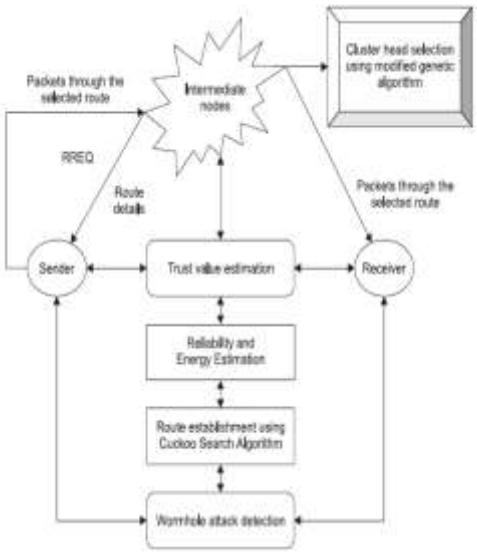


Figure2. Overall Architecture of Proposed System

3.2Cluster Head Selection using Modified Genetic Algorithm

The more number of sensor nodes are collected and to form the wireless sensor network, and to identify and transfer the data from the corresponding destination. These sensor node having the characteristics like less energy consumption, require less storage space and less calculation ability. To produce the energy in the sensor node the low energy batteries are used. In this network the energy is major trouble and to overcome these trouble the clustering models is used. By using the modified genetic algorithm the head of cluster has been chosen in the network. Based on the energy, distance between the nodes and the primary station the head of cluster has been determined. For this reason only, the wireless sensor device is known as power constraints. So that only, the highest distance node is selected for the wireless sensor device instead of minimum distance node with limited low power consumption.

In this present work the modified genetic algorithm is used to select the cluster head selection. For the selection process in the heuristic the genetic algorithm is used in the field of artificial intelligence. Another name of heuristic is metaheuristic and it is mainly used to optimization and search problems. Genetic algorithm is based on the evolutionary algorithms (EA) and it produces a result to the optimization trouble using some methods like inheritance, collection, cross over and mutation. The cross over operator is used in the genetic algorithm to differentiate the chromosomes process from the one age group to the next age group. It is similar to duplicate and genetic crossover, leading which genetic algorithms are based. Cross over genetic operator is defined as it is the process of taking more number of main results and produces a sub result corresponding to the main result. The traditional genetic algorithm is modified in its cross over operation by introducing the *k*-point crossover.

3.2.1. Fitness Function

For the power consumption the fitness value is assume for the optimal cluster head selection for this present work. In the EK network the *k*th round is showed in the network current energy. The following equation is used to calculate the fitness function and to get the lowest value. ***3.2.2. Reproduction Operator***

In the surroundings, the reproduction operator is the initial operator to choose at arbitrarily a couple of two particular strings for matching.

3.2.3. Crossover Operator

The recombination operator is called cross over operator. The cross over operator is used to select the highest string and the position values are exchanged between the two strings. The common cross over is enlarged to *k*-point cross over and *k* represents the swap the genetic node of main two nodes to generate a novel chromosomes. The point is depending on the cross over point which is randomly selected. To estimate the many number of cross over which the cross over rate is commonly 2-5%.

3.2.4. Mutation Operator

After the cross over process is done, the mutation operator will be applied in the strings. After the mutation process is done means the bit value is changed from “0” to “1”. This process make a possibility to change the common node becomes a cluster head and the cluster head is becomes to the common node. at last, both the cross over and mutation process is completed in the server station to choose the chromosome and it has the networks with lowest power differentiation in proportion to the existing stage and make the sensor nodes as the cluster head the another nodes connected to the neighbor cluster head. Based on the power, density and the centrality using the genetic algorithm the cluster head can be selected. The present work stages can be described in the following algorithm:

Step 1: preliminary network.

Step 2: every node sends the location of itself in the network to its nearest node.

Step 3: to evaluate the cluster head of BS by using the genetic algorithm based on energy, density and centrality.

Step 4: each and every node the Cluster heads are introduced in the network.

Step 5: Each sensor node will connect to the nearest CH.

Step 6: Each sensor node transfers the data to the CH with a multiple-hop transmission.

Step 7: the entire data packets are received from the destination node after that to aggregate the entire data's of CHs by using the HYMN algorithm and then transfer into the server station all the way through a single hop transmission.

Trust Based Routing Scheme: In this proposed work, the new trust based congestion responsive energy efficient routing method for wireless sensor networks is introduced and the cuckoo search algorithm is using make the most of network duration. Assume the random exploitation of sensor nodes in the sensor ground beneath free space proliferation. There are two phases are used to complete the present algorithm. In phase 1, to estimate the trust values and the congestion position of the nodes and by this means, the trust-congestion surroundings are created. In phase 2, to use the trust-congestion metric and the distance metric by using the cuckoo search algorithm and it is developed for the data packet routing from source node to the server node. The detailed process of phase 1 & 2 is described in the following sub section 1 & 2.

3.2.5. Stage 1

To detect the fault movement of the sensor nodes by using the topic of trust in this present work. The identification of the trusted nodes and the congestion positions are calculated correspondingly. The fault nodes having the trust value and this is not used by the data packet routing process, owing to the some nodes this congestion metric process is not calculated. This process makes a lessening in the computation overhead and by this means enhances battery life time. By using the three trust metrics such as remaining node energy (N¢e), packet transmission ratio (P¢TR) and packet latency ratio (P¢L), the trust value of the sensor node is estimated.

The congestion status of a suitable node is calculated by using the parameter. This process is called Congestion Index. Consider each and every sensor nodes manage a queue to store the data packets in its buffer. Sequentially, the data packets are transferred from one node to the next node and automatically the storage space of the buffer is cleared and the data packets are waiting in the queue to leave the empty buffer space of the sensor node. Compared to the packet transmission rate, the packet received rate is higher means, the queue length, buffer overflow and congestion status of the sensor nodes are also increased. Suppose, the node is not moving to the next stage from the queue means then the particular node waiting in the pre-defined cycles in some amount of time (WCmax) and maintain the packets in every cycle in anticipation of the packets are lastly dropped. It means, at the finishing stage of WCmax cycles.

3.2.6. Stage 2

By using the cuckoo search algorithm, the data routing protocol is implemented in stage 2. Another name of cuckoo search algorithm (CSA) is a meta-heuristic optimization algorithm to overcome the trouble and give the optimal result. The cuckoo bird is put down their eggs in some other crowed bird nest after estimating the host bird's nest. This estimation process is done based on the colors and features of the eggs of a particular selected other bird. It decreases the probability of the eggs being discarded and, consequently, improves the re-productivity scrounging cuckoos habitually select a nest where the other bird putdown their own eggs. The cuckoo eggs produce the eggs before the host eggs. When the baby cuckoo bird is hatched, the initial process is to throw out the host eggs by propelling the eggs out of the nest. After this process, the baby cuckoo bird gets the chance to take the food provided by its host bird.

Initialization: In the initialization process the number of nests is arbitrarily produced at the first step. In Table 3 this process is explained in detailed manner. Each and every nest the value is assigned arbitrarily "0" and "1".

Fitness selection: The critical feature of the cuckoo search algorithm is fitness selection process. It is used to calculate the better ability of persons result. Now, to identify the optimal route the lowest distance is selected as the best fitness. The fitness function is used to estimate the better path from the source node to the destination node. The fitness value is represented as *f*i and *i* is represented as sum of the distance between the two nearest nodes *n*j and *n*j + 1. The source node and the destination node is represented *s* and *d* correspondingly and the following equation is used to estimate the fitness function.In this present work, the trust congestion methodology is referred to as the fitness function. The following algorithm is described the cuckoo search algorithm:

Algorithm

Input: Trust Threshold Level, Trust Congestion Metric

Output: Optimal Route

Objective Function: $f(X)$, $X = (x1, x2, ..., xd)$

Generate an initial population of *n* host nests;

While ($t <$ Max Generation) or (stop criterion)
Obtain a cuckoo arbitrarily (say, *i*) and substitute its solution by performing Lévy flights;
Estimate its quality/fitness F*i*
[For maximization, F*i* μ *f* (*xj*)];
Decide a nest among *n* (say, *j*) arbitrarily;
if (F*i* > F*j*),
Swap *j* by the novel result;
end if
A fraction (Pa) of the poorer nests is discarded and novel ones are creating;
Maintain the best solutions/nests;
Grade the solutions/nests and get the present best;
Transfer the present best solutions to the next generation;
end while

New solution generation using Levy flight: The levy flight method is used to create the new methodologies. It is one kind of arbitrarily method. It is randomly search the length to create a new result which has a heavy-tailed allocation. Levy flight occupies the large search space in the specified region. Both the real and the imaginary programs work at arbitrarily in step sizes. To calculate the step size the various function set are used compared to the real programming code. The following equation expresses the calculation of the step size in the real code.
where,
0.01 Æ a factor for controlling step size of cuckoo walks/flights,

S*ti* Æ is current solution i of iteration t

Sbest Æ is the global best solution

Stepsize Æ is the length of walk step

≈ Æ is entry-wise product

U and *v* Æ are random value

b Æ Levy distribution parameter

From the above defined algorithm, better route establishment can be done effectively with the satisfaction of the research objectives namely energy, trust, reliability, trust and so on. After successful establishment of route paths, packets would be forwarded where there may be chance of the packet corruption/loss due to run time attacks such as worm hole attack. The protection of network from the worm hole attacks are discussed detailed in the following section.

IV. RESULTS

The network simulation (NS-2) is a very famous method of performance calculation of TERP process. In the entire work, the first energy of nodes is considered as 50 J, the energy threshold is 20% and the trust threshold is 0.6. Each and every node is assigned the trust value 0.5. Hundred sensor nodes are available in the network topology over an area of 1200 ¥ 800 m2. The unwanted and error node values are different from 1 to 10. The differentiation process is done between the Reliability aware energy and trust based routing protocol (RETRP) and Trust and Energy aware Routing Protocol (TERP). There are three parameters are used to estimate the trust value. There are,

- Control packet overhead
- Average hop count
- Average trust value of nodes

4.1 CONTROL PACKET OVERHEAD.

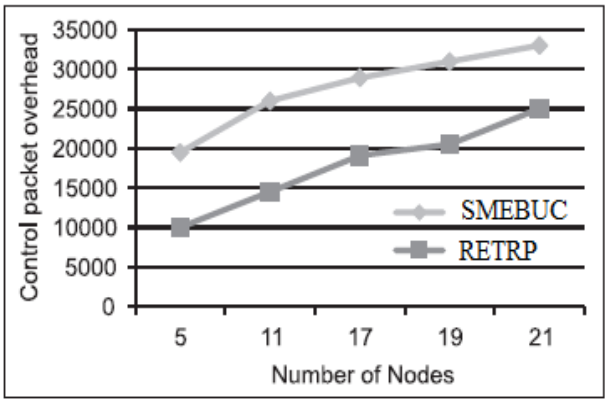
Some amount of time is taken to transfer the data packets on a corresponding packet switched network and this time is referred to as the packet overhead. Every data packet need a additional bytes to store the information in the packet header and it associated with the collecting and decollating the data packets and it also decreases the entire communication speed of the original data. Packet overhead should be less for the proposed methodology for achieving the better performance. The numerical values that are obtained for the packet overhead for both the proposed and the existing methodologies are given in the Table 1.

Table 1
Packet overhead value

Number of Nodes	Packet overhead	
	TERP	RETRP
5	19500	10000
11	26000	14500
17	28900	19100
19	31000	20500
21	33000	25000

4.2. Number of hops

Number of hops defines the number of hop counts required for the transmission of packets that are sending by the sender node. The lesser hop count consumed for the packet transmission would lead to better performance with improved security level. In Figure 4 illustrate the graphical representation of the hop count differentiation. Which it can be proved that the proposed method can transfer data packets with lesser hop count and more packet transmission ratio.



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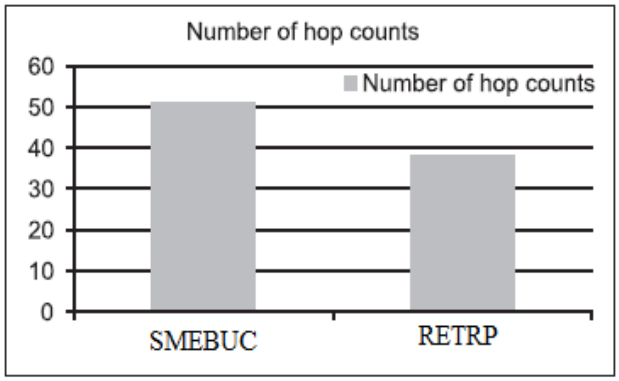
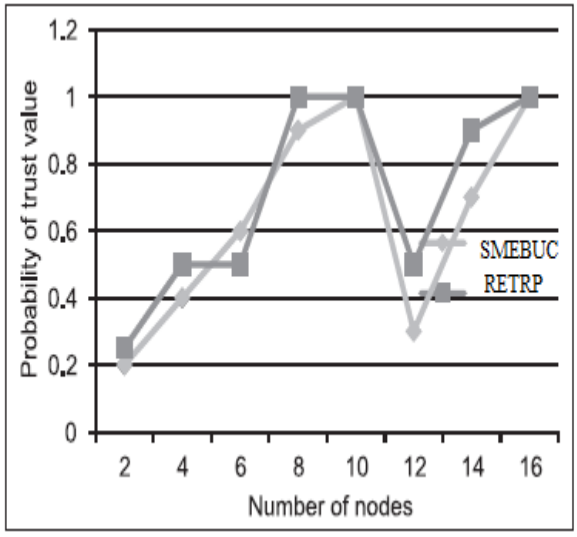


4.3 AVERAGE TRUST VALUE OF NODES

The better trust value defines the successful transmission of packets to the destination node securely without packet loss or collision. Based on the probability value the trust value is estimated. The differentiation of the calculation is illustrated in Figure 5.



Conclusion and Future Work

In wireless sensor network, routing is a major task for the transferring the packets between the number of nodes for achieving the successful and secured data transmission. There might occurs many issues while forwarding the data through the unsecured nodes. In this present work, the Reliability aware energy and trust based routing protocol (RETRP) is developed and it concentrate the implementation of the secured route path between the source node and the destination node. In future, the wormhole attacks are discovered at run time for avoiding the packet loss rate

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