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Improved EESCA Algorithm to Reduce Energy Consumption of Wireless Sensor Network

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***Abstract*---- A distributed type of network in which there are large numbers of sensor nodes deployed such that the surroundings of the area can be monitored and important information can be gathered is known as wireless sensor network. The sensor nodes present within the network are very small in size and have very less power for processing the tasks. The approach in which the original data is combined into smaller sized data such that only important information can be forwarded to the individual sensors is known as aggregation which is used within EESCA. The algorithm called ant colony optimization is applied for the path establishment from source to destination. The proposed algorithm is implemented in MATLAB and results are analyzed in terms of certain parameters. It is analyzed that in the proposed algorithm number of dead nodes are less, and number of packets transmitted to base station are also high as compared to existing EESCA algorithm.**

***Keywords*--- EESCA,WSN, Lifetime**

I. INTRODUCTION

In ancient time, the environmental monitoring was quite popular. In the early period, analog methods were employed to measure the parameters of physical environment. Wireless Sensor networks were emerged due to the current growth in wireless networks and electronics. Wireless network is a very prominent technology. This technology has the potential to transform the future into ideal. These networks are made up of small battery–energized sensor nodes. These sensor nodes are also called as motes. These motes have inadequate computation and radio communication potential. In a sensor network, every sensor is made up of three subsystems [1]. The first subsystem is called sensor subsystem. This sub system senses the environment. The second is processing subsystem. This subsystem executes local computations on the sensed data. The third subsystem is termed as the communication subsystem. This subsystem is accountable for message sharing with adjacent sensor nodes. In medical field, the growth in wireless sensor networking has launched novel visions. The new medical tools are developed by the sensor-based technology. In hospitals, these medical tools have replaced thousands of wires connected to these devices. The technology of wireless sensor network has the potential to provide trust worthiness along with improved mobility. The sensor nodes of wireless sensor networks are low-energy devices. These devices are deployed with computer, storage, a power supply, a transceiver, and one or more sensors and sometimes with an actuator [2]. Different types of sensors like chemical, optical, thermal and biological can be linked to wireless sensor nodes. As compared to the standard sensor devices, these wireless sensor devices are tiny and cost-effective. In order to generate an ad-hoc multi hop network, the wireless sensor devices can arrange themselves in automatic manner. Several hundred or may be thousands of ad-hoc sensor nodes are available in wireless sensor networks. These sensor nodes works together for performing a general task. Some of the major features of these networks are identified as self-organizing, self-optimizing and fault-tolerant. In comparison with the conventional sensing means, the wide-ranging network of economical wireless sensor devices provides a golden opportunity for the more accurate monitoring of physical environment. Various design and resource limitations occur in wireless sensor networks. The design limitations are related to intention and the features of the deployment situation. The network size, installation technique and the network topology are driven by the surroundings. Limited energy extent, less communication range, low network throughput and decreased storage and computing resources impose resources constrains. A package of micro sensors deployed within a rigid region is called wireless sensor network. The space of sensor is a particular situation and route for sensed data to moderately manage processing node termed as sink. In wireless sensor network, energy is a vital resource for battery powered sensor nodes. This factor increases the life of network. The design of wireless sensor node has become one of the fundamental aspects of

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energy competence. Due to the limited energy of the system, most of the existing routing schemes try to find minimal energy path towards the sink. Some significant points should be noted in relevance of energy consumption and the network lifetime to deal with routing issue. These points include energy depletion, unequal energy allotment, movement of nodes, relay of nodes, and node distribution as per the traffic pattern, data aggregation and energy equilibrium routing. Energy is an extremely important resource in all cases. The energy should be used carefully. Thus, in the wireless sensor networks, the energy preservation is an important constraint in system designing [14]. Though, various energy routing protocols have been proposed for attentive energy competence to discover optimum path for minimizing the consumption of energy.

II. LITERATURE REVIEW

M. Vahabi, et.la (2007) proposed a data dissemination algorithm. The proposed algorithm exchanged the power utilization with source-to sink delay at various levels [21]. For this purpose, the communication array of the sensor was decomposed into definite ranges. Further, these ranges were classified according to their external radius. The simulation results depicted that the less energy was consumed by decomposing the transmission range into CCs based level of Interest. Furthermore, the proposed algorithm provided a direct path between a source node and the sink. This resulted in the less power expenditure

M. Ramakrishnan, et.al (2009) reported an experimental study of power utilization within the wireless sensor networks [22]. In this work, a new power calculation method was proposed to make the measurement of power simpler in big sensor networks. In PICSENSE nodes, the implementation of two MAC protocols called CSMA/CA with RTS/CTS and CSMA/CA with eavesdropping prevention was done. The obtained results depicted that the eavesdropping prevention should be introduced to save the energy significantly. The power utilization of the CSMA/CA with eavesdropping prevention was identified 6% to 19%, 7% to 27% and 11% to 33%. This power consumption was lower than the CSMA/CA devoid of eavesdropping prevention for 3, 4 and 5 node design correspondingly. It was also analyzed the percentage of energy conservation increased with the increase amount of sensor nodes within the network. In this work, processor duty cycling approach was proposed. In this approach, the processor was put into inactive state sporadically for energy conservation. The processor duty cycling saved the energy up to 5 to 6%. The energy conservation by controlling the transmission power will be studied in the nearby future.

Wan Du, et.al (2010) proposed an energy model for wireless sensor network. The energy prediction of both the entire sensor network and the elements in a particular node were enabled by the proposed energy model [23]. On the basis of electrical features on the datasheet of hardware elements or test bed measurements, the proposed energy model could be adjusted effortlessly according to the dissimilar types of sensor nodes. Some test bed measurements were used to calibrate and validate the proposed energy model. Huan Gong, et.al (2010) proposed a novel low-energy wireless sensor node design to monitor the wireless sensor network [24]. In this work, a control application was also initiated to review the power expenditure source of wireless sensor node. This work discussed the power-saving technology regarding integrated circuit (IC), energy handling and data transmission that reduced the power consumption of the system in enormously.

P. Murali, et.al (2010) examined the important feature of energy handling in wireless sensor network at a network level. In this work, a specific clustering-based strategy was considered. The two metrics of virtual hop number and a definite usage pattern ratio was utilized to derive a model that considered the more energy expenditure procedures [25]. The energy exploited by the overall network was compared with the probable produced solar energy. For the known topology, the realism of an energy neutral process was surveyed as well. The extent of study was certainly huge in the heterogeneous networks having broad applications. Though, the study could be more useful for those networks in which non uniform and multi-source energy production was possible.

Hao Liu, et.al (2011) stated that wireless sensor networks faced a serious energy consumption issue. A novel scheme was proposed in this work to optimize the consumption of energy. The proposed approach was based on the parallel ant colony algorithm (PACA) [26]. The proposed scheme was able to explore the solution and optimized the path of data transferring for regulating the power expenditure of the sensor nodes. The algorithm was divided into several fractions. Embedded MCU on the nodes could completely operate the nodes. The simulation results indicated that the proposed scheme more efficiently regulate the power consumption of the nodes as compared to the directed diffusion routing method. The proposed scheme also increased the total life span of the network efficiently.

Hyunchul Kim, et.la (2011) presented a study of energy-efficient resource distribution formats in Wireless Sensor Network (WSN) [27]. In these networks, the deployment of sensor nodes was done in dense way with

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framework assistance. Initially, a network method was built. This method computed the consumption of energy without any smart resource handling plan for a specified quality-of-service limitation. This constraint was described as Signal-to-Interference-plus-Noise Ratio (SINR). The optimal power reduction approaches were presented on the basis of general and adaptive energy transmission in SINR restraint. The minimal power consumption could be attained for a known channel bandwidth as per the obtained simulation outcomes. This happened when nodes robustly managed the transmit signal power according to the condition of the channel

Plamen Z. Zahariev, et.al (2012) investigated the schemes to organize the clusters within wireless sensor networks (WSN) [28]. In this work, the transmission design and the power distribution model were presented by giving small preface to these systems. These schemes were employed for the hierarchical cluster-based wireless sensor network. The existing extensively utilized process for clusters association was analyzed in the third part of the work. In this part, its major drawbacks were outlined as well. Afterward, a strategy for balanced energy consumption by the sensor nodes was presented. In this work, a modification to this strategy was proposed as well. The results of a sequence of simulation tests were presented and analyzed in the subsequent part. These tests were performed on the proposed approach. The simulation results of proposed approach were compared with the results obtained from the simulation tests of other existing approaches. Zhenxing Luo, et.al (2012) employed a multi-objective strategy for the balancing of power expenditure and performance in wireless sensor networks (WSNs) [29]. In this work, maximum likelihood estimation (MLE) plan was used to localize the energy-based target. Initially, some methods were developed. These methods allowed the balancing of power utilization and performance in one-dimensional sensor range. After that, these measures were extended for two-dimensional arrays. These methods used estimations that facilitated the power expenditure. In order to produce the Pareto-optimal fronts for both one-dimensional and two-dimensional sensor arrays, some simulations were performed. The Pareto-optimal fronts played an important role to determine the optimal points actually.

Jiaying Song, et.al (2012) presented the energy expenditure scrutiny of ZigBee-based energy harvesting wireless sensor networks. The main aim of this work was to recognize the energy needs of the energy harvesting technologies in a realistic way [30]. In order to inspect the major factors affecting the framework of energy harvesting technology, three types of energy expenditure were examined. These energy consumptions included the energy expenditure of end devices and routers in active mode, the energy expenditure of data transmission with and without application assertion needs, and the energy expenditure of routers helping dissimilar node weight. A summary of main factors affecting the life span of wireless sensor networks was provided on the basis of assessment. In addition, energy expenditure model was projected for evaluating the life span of a sensor node. Furthermore, for ZigBee-based energy harvesting wireless sensor networks, a discussion on the possible energy-saving solutions was carried out.

Abhishek Chunawale, et.al (2014) proposed a novel approach of clustering for CH selection and cluster configuration in wireless sensor networks. The proposed approach divided the sensor network into zones according to the geographic positions of sensor nodes [31]. The residual energy of nodes and node distance was considered for the formation of clusters in the zones. The overall sensed data was sent by all the cluster associates to their relevant cluster head. Thus, the more energy was exploited by the cluster head due to the processing of gathered data before its transmission to the Base Station (BS). The cluster reformation was initiated by reducing the remaining energy of cluster headless than the threshold value. According to the amount of sensor nodes and transferring range, the performance of the network was analyzed and simulation results were obtained. The tested outcomes depicted that the proposed approach performed well in terms of certain parameters. These parameters included decreased energy expenditure, better network life span and network scalability.

III. RESEARCH METHODOLOGY

This research work is related to improve lifetime of wireless sensor networks. The EESCA is the efficient routing protocol of wireless sensor network which increase lifetime of EESCA protocol. The EESCA routing protocol use the concept of clustering to increase lifetime of wireless sensor networks. In the approach of clustering, the cluster heads are selected in each cluster. The network is divided into clusters on the basis of sensor node location. The cluster heads are selected in each cluster based on distance and lingering energy. The technique of particle swarm optimization will be applied to improve lifetime of wireless sensor networks. The ant colony optimization technique will work in the three phases. The actual behavior of ants is considered as a base in this algorithm. A local data related problem is considered here in which the parallel search is made over various constructive computational threads. The quality of previously obtained results is presented on the basis of information gathered from dynamic memory structures [7]. The combinational optimization (CO) problems have been effectively solved using collective behavior. The various search threads interact with each other and that is when variorums such issues arise. So, in case of static and dynamic combinatorial optimization problems a current application of ACO algorithms has been used. A randomized heuristic construction is implemented by ants in ACO. As a function to be provided within the artificial pheromone trails, the probabilistic decisions are generated within this algorithm. On the basis of heuristic information, the problems of input data are resolved here. Within various combinatorial optimization issues, the traditional construction heuristics are extended within this algorithm. There are mainly four steps involved in the proposed technique [15]. They are the initialization process in which ants are randomly placed over the image and the pheromone values along with the heuristic information is computed, the construction process of node transition rule which ants are chosen and moved for a certain number of steps probabilistically in addition to deciding the admissible range of the ants, the pheromone update process in which comparison is done between the threshold value (t) which will be computed through PSO, and heuristic value and the termination criterion which specifies after these many iteration the algorithm will come up with the result. Below is the process followed using these steps:

4.1. Initialization process: Within an sensor nodes coordinate i, m numbers of ants are randomly distributed over the sensor nodes I which has a size of M×N where M is the height and N is the width of the sensors I such that at most one ant can be present at any pixel. The pheromone value at all the pixels or nodes is considered to be 0.0001 which is initialised in Tinit. Here node and pixel can be used interchangeably. The heuristic information will be computed offline for all the pixels. 4.2. Construction process of node transition rule: A stochastic approach is utilized to select kth ant from the m artificial ants in the nth construction step. Within an coordinated of sensor nodes i, there is a continuous mobility of this ant from node (r,s)towards its neighboring node(i,j). The node transition rule is followed here and the equation generated is:

$$P^{\eta}_{(r,s),(i,j)} = \begin{cases} \dfrac{\left(\tau^{(n-1)}_{(i,j)}\right)^{\alpha}\left(\eta_{(i,j)}\right)^{\beta}}{\sum_{(i,j)\epsilon\Omega(r,s)}\left(\tau^{(n-1)}_{(i,j)}\right)^{\alpha}\left(\eta_{(i,j)}\right)^{\beta}} & if\ (i,j)\epsilon\,\Omega(r,s) \\ 0 & Otherwise, \end{cases} \quad ---(1)$$

Here, for node (i,j), $\tau^{(n-1)}_{(i,j)}$ and $\eta_{(i,j)}$ are the pheromone and heuristic information values respectively. The heuristic information for all the pixels will be calculated offline and the region size taken is 5×5. The heuristic information is a very parameter to be considered because it will act as an indicator for the ant that in its vicinity where it has to move. Heuristic information is quite similar to finding out the gradient of destination. The diagram below shows the region. The various colors present in the diagram have no meaning by themselves; they just refer that we will check the difference between the intensity values of same colored pixels. The Ant colony optimization algorithm is applied for the shortest path establishment from source to destination. The ant colony optimization algorithm is applied based on the Euclidean distance. The formula of Euclidian distance is defined below

$$\text{Euclidean Distance} = \sqrt{(X1-X)^2+(Y1-Y)^2}$$

The X1 is the X coordinate of base station X is the X coordinate of source node. The Y1 is the Y coordinate of base station and Y is the Y coordinate of source node.

IV. RESULT AND DISCUSSION

Following are the various parameters which are used for the performance analysis: -

1. Throughput: - The throughput is the parameter which is used for the performance analysis. The throughput parameter measure number of packets which are successfully received at the destination in the per unit time

$$\text{Throughput}=\frac{\text{Number of Packets Received at Destination}}{\text{Total Number of Packets Transmitted}} \text{*time}$$

2. Alive Nodes: -The numbers of alive nodes define that nodes whose energy is not gone to zero

3. Dead Nodes:- The number of dead node is the parameter which count number of dead nodes in the network

Dead Nodes=Nodes which has zero energy

Table 1: Simulation Parameters

Parameter	Description	Value
A	area of network	(0, 0)–(100, 100)
L-BS	BS location	(150, 250)

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N	number of nodes in network	100
$E_{initial}$	initial energy of all nodes	0.5 J
E_{fs}	free space channel model	50 nJ/bit
E_{mp}	multi-path fading channel model	0.0013 pJ/bit/m^4
d_0	distance threshold	87 m
E_{DA}	data aggregation energy	5 nJ/bit/signal
DP size	data packet size in bit	4000
CP size	control packet size in bit	200

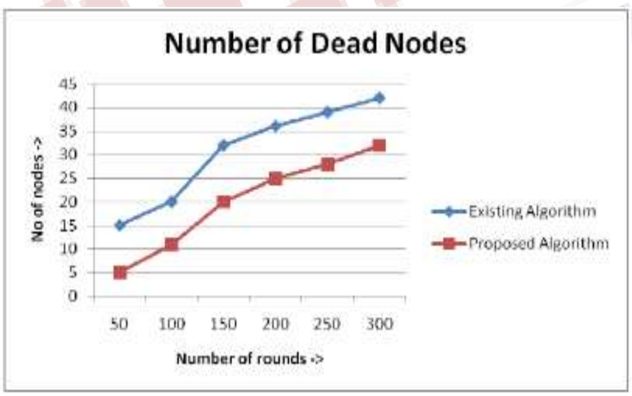

Fig 1: Number of Dead Nodes Analysis

As shown in Fig 1, the existing technique in which cluster head are responsible for the data transmission to base station is compared with the proposed algorithm in which ant colony optimization is applied for the path establishment. It is analyzed that proposed algorithm has less number of dead nodes as compared to existing algorithm.

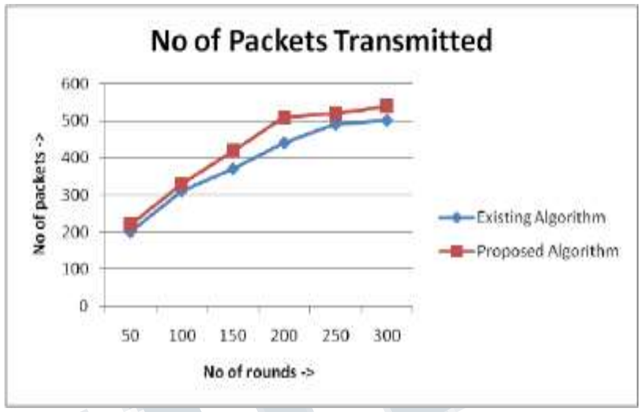

Fig 2: Number of packets transmitted

As shown in Fig 2, the existing technique in which cluster head are responsible for the data transmission to base station is compared with the proposed algorithm in which ant colony optimization is applied for the path establishment. It is analyzed that proposed algorithm has more number of packet transmission as compared to existing algorithm.

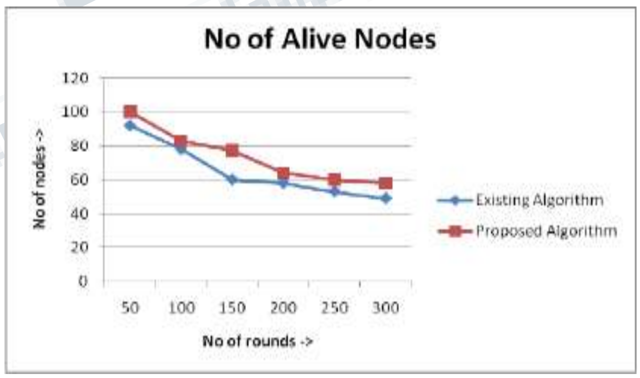

Fig 3: Number of Alive nodes

As shown in Fig 3, the existing technique in which cluster head are responsible for the data transmission to base station is compared with the proposed algorithm in which ant colony optimization is applied for the path establishment. It is analyzed that proposed algorithm has more number of alive nodes as compared to existing algorithm.

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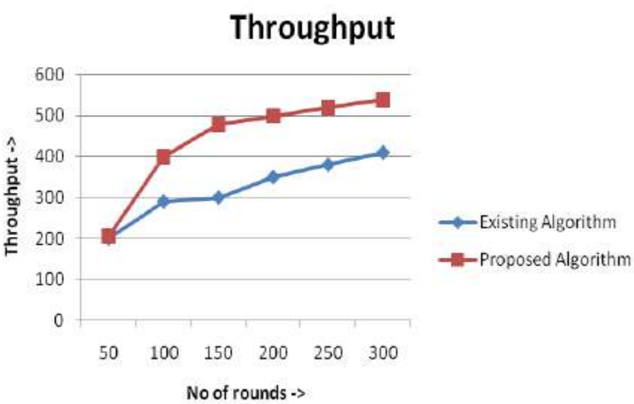

Fig 4: Throughput Analysis

As shown in Fig 4, the existing technique in which cluster head are responsible for the data transmission to base station is compared with the proposed algorithm in which ant colony optimization is applied for the path establishment. It is analyzed that proposed algorithm has more throughput as compared to existing algorithm.

V. CONCLUSION

Due to small size of sensor nodes and far deployment energy consumption is the major issue of wireless sensor networks. The WSNs are used for object tracking, intelligent forming, congestion controlling, military application, survival monitoring and much more. Several issues are also presented in wireless sensor networks like development of a comprehensive addressing for the whole sensor nodes, security, small calculation capability, restricted and not chargeable battery and small memory. The proposed methodology will improve lifetime of the wireless sensor networks. The proposed algorithm is implemented in MATLAB and results are analyzed in terms of dead nodes and number of packets transmitted to base station. It is analyzed that number of dead nodes are reduced and number of packets transmitted are more as compared to existing approach.

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