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A Secure and Energy Efficient Sensor Nodes in Wireless Sensor Networks using Improved Ant Lion Optimization

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Abstract: - The Wireless Sensor Network (WSN) has three critical issues as like network lifetime, saving energy and security. A sensor node has limited battery power so it does need an effective key distribution and management mechanism for a safe communication. In the research literatures a massive key supply and administration methodology had been proposed. Thus, there exists a literature report of numerous schemes in WSNs for Key management and done with a wide analysis to classify the available techniques of key management and the expectable network security on them is studied. In this method a secure efficient key management scheme is proposed with the help of Ant Lion Optimization (ALO) for WSN. The aim of this method is to obtain improved security strength with cost effective. The nature of the ant lion in hunting its prey is derived for the ALO algorithm which known for its meta-heuristic function. In resolving the optimization complications with the advantage of having a great speed and limited parameters it is proved to have a better performance.

Keywords: Ant Lion Optimization, Schemes, Evolutionary Algorithms, Energy Optimization, Key Management Wireless Sensor Network

I. INTRODUCTION

The key management issue in a Wireless Sensor Networks (WSN) can be decom-presented into four stages. In first, the key sharing or pre-distribution stage where mystery keys are dispersed to sensor hubs for use with the security systems (i.e., privacy, confirmation and respectability).

In a huge scope WSN, it might be infeasible, or even incomprehensible in uncontrolled conditions, to visit huge number of sensor nodes and change their security setup. In this manner, keys and keying materials might be pre-circulated to sensor nodes in a focal area from the earlier to the arrangement. This state as such, is named as the key arrangement.

The second is the mutual key disclosure stage, which begins after the sensor organize, every sensor node finds its neighbors and a typical key with every one of them. The key foundation stage, named is as the third stage where in each pair of the approaching nodes, there exist no regular keys, and at least one key is propelled. Key foundation between two hubs can be accomplished by utilizing pre-dispersed keying materials and by trading messages straightforwardly over their unreliable

remote connection or more than at least one secure ways on which each connection is made sure about with a secret key sensor nodes have a constrained life time, and they are dependent upon assortment of assaults including capturing the node. In this manner, the fourth is the key update stage where the security keys which are utilized to make sure about the connections between neighboring hubs are refreshed.

In this procedure the Ant Lion Optimization is utilized to develop a made sure about sensor quality and reducing resources. Cryptographic approach and cryptographic key are the two elements choosing cryptography. The calculation chooses the encoding and decoding method with the key as a parameter utilized by the capacity. The complete security quality is made by the calculation with a few targets named as key newness, key verification and key trustworthiness. In this scientific calculation of ALO technique the nearby optima evasion is high because of the inconclusive idea of developmental calculations. The calculation is advanced because of the No Free Lunch hypothesis which permits specialists to structure new calculations in which all calculations perform comparatively to any enhancement issue. The ALO calculation is made for the savvy conduct of ALO in chasing ants in nature, this gives the elective procedure to move toward the advancement issues.

The key constraints involved in this methodology are shown in Figure 1 flow chart. Thus, the key enhancement is being evolved with the algorithms proceeding with the optimization problems.

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The ALO algorithm is mainly used in this process to provide the high speed and is curated to optimization algorithm based on the mathematical model.

This section is designed to share about some of the main problems in WSN and its key enhancement methods used in the ALO algorithm. The maintenance and implementation of key management is been mainly proposed with the optimization problems of WSN. In this manner, a detail survey and foundation study is made in Section 2. Segment 3 gives the specific issue which is recognized from the overview. Segment 4 states investigate approach that contains customary calculations, molecule swarm streamlining and the proposed insect lion advancement for improving key administration. To check the trial results, segment 5 gives detail correlation among all strategies. At last, in section 6 the wrap up with summary is done with future directions.

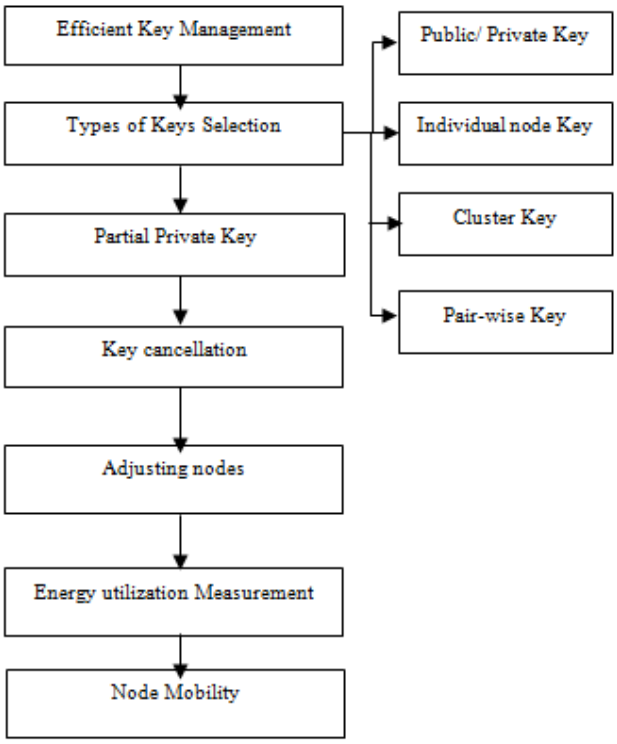

Fig 1. Key Management Flow diagram

1.1 SENSOR NETWORKS

Extensive empirical studies are confirmed that the quality of radio communication between low-power sensor devices varies significantly with time and environment. This phenomenon used static transmission power, transmission range and link quality, might not be effective in the physical world that will be indicated by the topology solutions. To address this issue, online transmission power control that adapts to external changes is necessary. A lightweight algorithm for Adaptive Transmission Power Control in wireless sensor networks. This model contains a feedback-based transmission power control algorithm and its used to dynamically maintain individual link quality over time. From the survey, reveals that a high demand of powerful network functionalities is faced by the today's network computing. Functional network reach is central to customer satisfaction such as in mobile networks and cloud computing environments. However, efficient management of WSNs remains a challenge, due to problems supplemental to them. Recent technology shift proposes Software Defined Networking (SDN) for improving computing networks. Wireless Sensor Network (WSN) applications and techniques require sensor location to work correctly. Information fusion in WSNs is crucial for location discovery. Several location-discovery algorithms use the information fusion techniques. In this paper, we provide an overview of information fusion techniques use the position computation process and it simplified by localization algorithms.

1.2 KEY MANAGEMENT

In group key management the security aspect uses the efficient method and algorithm. This method makes the groups into subgroups, each group and subgroup members are managing the group key which can be allocated secrets to and when leaving the inverse value of secrets respectively. Every group and subgroup members have to keep others inverse value. If a new member joins in the group by using IP multicast then they will receive a new inverse value of the particular member.

Later on, measuring the energy adaptability act of equipment's, the initial process to effectual energy managing in the making is the procedures and factories. Hence, the manufacturing company producing the energy efficiency goals is allowed to calibrate by the authorized energy correlated information. The examination of this research describes the lacking methods in the current industry, suitable comparisons for energy usage of machineries and procedures profiles with the behavioral indicators and also the energy competence act with that of its opponents is made under comparison.

II. LITERATURE SURVEY

Ali et al., [4](2017) they propose a work to obtain clean and smart solution to the increased demands is supplied by renewable sources. Thus, for resources of Distributed Generation (DG) Photovoltaic (PV) and Wind Turbine (WT) are taken. The system loss affecting sources in DG is that the region and diameter. This article is about the several distribution systems ideal region and diameter in basis of DG's sustainable sources of ALO algorithm is produced. The DG is equipped utilizing the Loss Sensitivity Factors (LSFs) by introducing the maximum candidate buses. Later, for the purpose of deducing DG from the elected buses of its region and diameter the ALOA is proposed. After proposing the algorithm, it is set for testing on two of the branching distribution systems in IEEE. The study resulted in accordingly increasing the net barring and decreased in overall power loss through the proposed algorithm in contrast with the other algorithms. Here, the verification of the benefit of ALOA is tested with the Wilcoxon test. Likewise, they were shown to verify the loading conditions and the improvement on voltage profiles for various distributed systems in the ALOA efficiency.

Heidari et al.,[5] (2020) proposed a work based on the Ant Lion Optimizer (ALO) is capable method for neural network training. Antlions are naturally moving from one place to another, hence ALO is giving ideas for capturing those antlions. In this paper its clearly giving hypothesis and expression based explanations is compared with few of key management algorithms. Oliva et al.,[6] (2018) proposed a work based on Multilevel Thresholding (MTH) is used for image segmentation to obtain the frequency with limitation by not considering the spatial domains. Contextual information can help to improve the quality of the separated image as it deals with not only the value of the pixel but also its vicinity. The spatial information is a design of energy curve into a curve with the same properties as the histogram. The ECAs picked up are the Sine Cosine Algorithm (SCA) and the Ant Lion Optimizer (ALO). The research undergoes with comparison of algorithm against the similar approaches by presenting a statistical examination and quality of the proposed methods are intensively evaluated. The Tentative proof motivates the utility of ALO for MTH whilst the state-of-the-art for the SCA does not beat the other ECAs as resulted in conclusion. This technique is stated as the constrained optimization algorithm. The convergence of the meta-heuristic search algorithm acquires the solution for the problem.

III. MATERIALS AND METHODS

1.3 ANT LION OPTIMIZER

Mirjalili (2015) presented a new optimization technique called The Ant Lion Optimization algorithm to perform the optimization problems in WSN. The Antlions are inspired from its catchy nature of finding its own prey in the bare sand land. The antlions mainly include two phases in its life cycle: which are Larvae and Adult. The larvae mostly hunt and the adulthood is for reproduction.

The antlions dig round shaped pits in the sand and sit in and wait for its prey. It throws away the sand while digging out the pits and when a prey (say, bugs or ants) they catch them for consumption. Though the ants can't be caught suddenly, the antlion uses its intelligence by throwing the sand to top of the pit to slide in and catches the prey with its jaw. Once the prey is caught it consumes and throws away the waste of the prey to keep the pit for further consumption.

The antlions are the insects which digs the pit as its level of hunger and based on the size of the moon. This interesting factor has been evolved for ages of antlions in its lifespan, in which it does not directly link to shape of the moon but it contains internally a lunar clock in it for the survival.

1.4 The Improved Ant Lion Optimization Algorithm

In a brief sketch of the ant lion method here, for a definitive description the reader is referred to a new enhanced speculative search algorithm is termed as the ALO, which is a nature inspired system of hunting approach, in which the solutions for finding the prey and hunting is defined by steps and proposed the ants and antlions as the exploration agents, including the arbitrary walk of the ants, construction of trap, ants allurement in traps, capturing the prey, and reconstructing the traps. The ALO description in the mathematical methodology is followed as,

When ants are moving naturally for searching food by based on optimization method of random can be defined as:

$$Xi = [0; r(1); r(1) + r(2); \ldots; \sum_{j-1}^{T-1} r(j) \sum_{j-1}^{T} r(j) \quad (1)$$

Where i = 1, . . . , dim, dim is the ant or antlion dimension, T is the maximum number of iteration,

$X = [X_1; \ldots ; X_{dim}]$, X_i is a (T + 1) * 1 matrix, and r(j) is a stochastic function and can be expressed as:

$$r = \begin{cases} 1, & if\ r\ and > 0.5 \\ -1, & if\ r\ and \leq 0.5 \end{cases} \quad (2)$$

Here r denotes arbitrary number produced from the interval of [0, 1] in a uniform distribution.

The actual search area conferring to the upper and the lower edge of the position should be converted to the Ant's Arbitrary walks. It can be calculated using Equation (3):

$$Y_i = \left(\frac{x_i - a_i}{b_i - a_i}\right) x\ (d_i - c_i) + c_i \quad (3)$$

Here a_i and b_i represents the term X_i - minimum and maximum, c_i, and d_i denotes the antlion in the ith magnitude for its minimum and maximum respectively, $Y = [Y_1; \ldots ; Y_{dim}]$, (T + 1) * 1 matrix.is denoted for Y_i. X_i is normalized in the domain [0, 1] using $\frac{x_i - a_i}{b_i - a_i}$ .Then it is converted into the domain $[c_i, d_i]$ using Equation (3). This describes to mean the selective antlion's location surrounding it. The antlions' trap disturbs the navigation of the ants. This can be described as:

$$c = c' + Antlion,\ d = d' + Antlion \quad (4)$$

Here c' and d' indicates the current iteration's fluctuating limits of minimum and maximum, the location picked by the Roulette wheel of Antlion is the Antlion, conferring to the suitability. The hope of construction of Antlions trap is based on the proportional to its suitability. The ant's sliding process initiates at once when the antlions recognize that the ants got into trap and seeks to elope. Utilizing the Equation (5) c' and d' are updated:

$$c' = \frac{lb}{10^W \times (t/T)},\ d' = \frac{lb}{10^W \times (t/T)} \quad (5)$$

Here t indicates the present iteration, the limits are represented as ub and lb, correspondingly, the term W, based on the current iteration it is denoted as a constant. (if t > 0.1 T then W = 2, if t > 0.5 T then W = 3, if t > 0.75 T then W = 4,if t > 0.9 T then W = 5, if t > 0.95 T then W = 6).

Here the Y is a (T + 1) * dim matrix which is been easily found and can be computed in the sequence of Equations (5), (4), (2), (1), and (3).

The Arbitrary walk near the antlion chosen by Roulette wheel and exclusive for every ant tends to update its locus. It can be determined as:

$$\text{Ant} = \frac{R_A + R_E}{2} \quad (6)$$

Here, Ant states the new location, the arbitrary walk round the antlion carefully chosen by the roulette wheel is indicated as RA, the arbitrary walk round the exclusive denotes RE. If it is beyond the edge limit, the ant should be altered with the new location. The antlion must grasp its location, if the lowermost part of the pit reached by the ant and if the ant would be fitter than the antlion. Thus, this procedure is termed as prey catching and is granted as:

$$\text{Antlion} = \text{Ant if } f(\text{Ant}) < f(\text{Antlion}) \quad (7)$$

where f (•) is the fitness function. The Fig2. portrays the ALO algorithm and its flowchart.

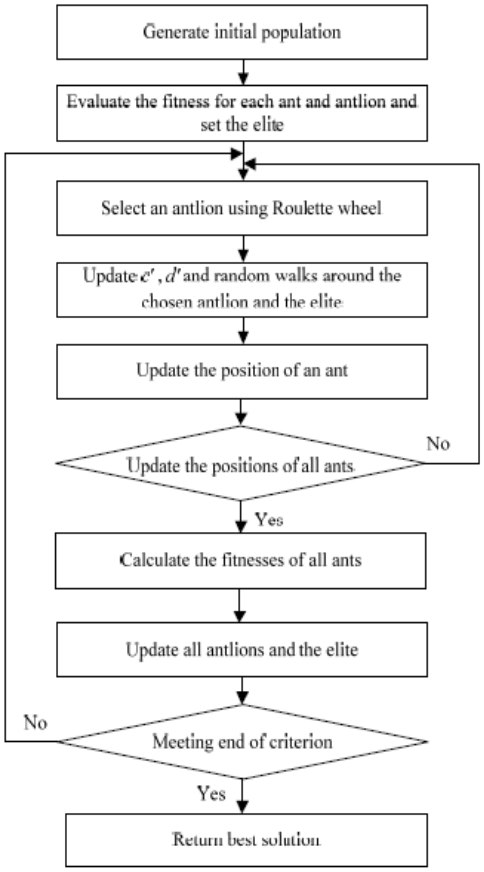

Fig. 2. The algorithm of ALO and its Flowchart

3.3 Improvements on ALO

The location of the ants in the ALO algorithm is renewed on the basis of the arbitrary walks they go through the antlion depending on the Chosen Roulette wheel and its exclusive, and fixing the elite in the process of searching would provide the finest preserved particle. Thus, by attaining such decision bring the advantages for ALO algorithm like as to have reckless speed of calculation, great efficacy, and a decent convergence. Then, the complex optimization issues contain different phenomenon for the local optimal and premature conjunction. To develop the optimization capability and the accuracy it is added with a few enhancements.

3.4 Key Generation

The interpretation keys and process of encoding related to image utilization for problem identification and accuracy for ensuring security is given. The public and private keys for key management additional specifications are (H_{pk} and H_{sk})

$$K = cd \text{ and } \omega = \text{lcm}(r-1, s-1) \quad (8)$$

This ALO ensuring security structure for images creating random keys for encrypting and decrypting for getting public and private keys.

3.5 Key Generation for Ant Lion Optimization

Generally the ants are moving from one place to another is compulsory for reflecting necessary communication. That can be in terms of following equation

$$\text{Opt\_key} = \{0, cs(2r(t_1\ 1)), cs(2r(t_2\ 1)) \ldots\ldots\ cs(2r(t_n\ 1)) \quad (9)$$

$$r(t) = \begin{cases} 1, & if\ r\ and\ > 0.5 \\ 0, & if\ r\ and\ \leq 0.5 \end{cases} \quad (10)$$

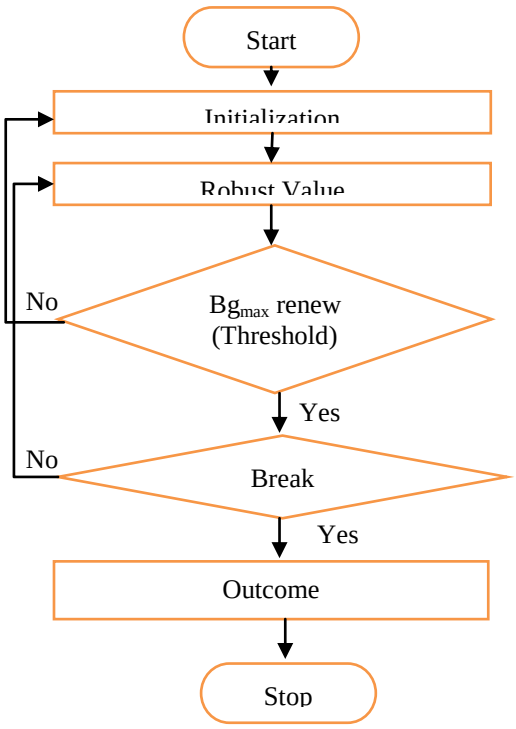

Fig. 3. Using ALO in Key Generation

Where, cs - Cumulative aggregate, n - Max Number of Iteration, r(t) - Stochastic capacity. In any case, above condition can't be direct used for refreshing the situation of ants. With a particular ultimate objective to keep the discretionary walks around the interest space, they are normalized using Min-Max Normalization process.

$$K, n(t) = \frac{\left(k_i^f - m\left(1/k_i^t\right)\right)^{*}(U(t)-L(t))}{\left(m(k_i^x)-m(k_i^f)\right)} \quad (11)$$

It defines the minimum and maximum of a random walk for the variable of nth ant, U(t) and L(t) is the upper and lower bounds of the dth variable at t^{th} iteration.

IV. EXPERIMENTAL RESULTS

The result of the proposed ALO based key management method is compared with few existing key management methods is given in the form of graph in Fig.3.

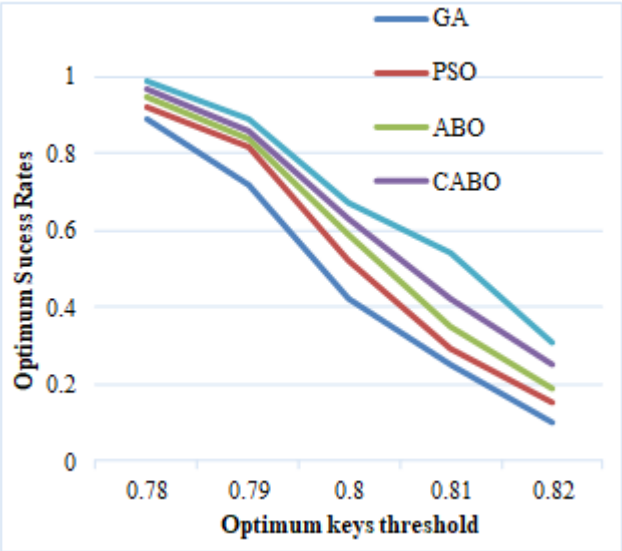

Fig. 4 Optimum success rate comparison

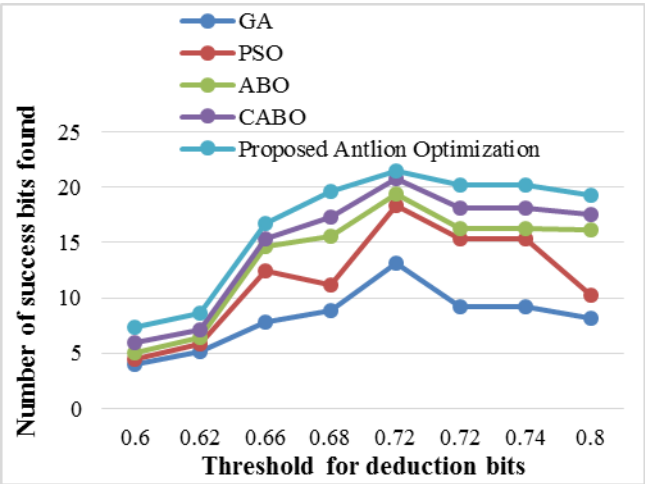

Fig. 5. Threshold Vs Success Bits

These two graphs fig. 3 and 4 are showing that Ant Lion Optimization is having better security based on unique data encryption compare with other methods like GA, PSO, ABO and CABO. The better performance is given by comparing the parameters like bit rate and threshold value.

The outcome shows that it has robust flexibility and the achievement factor is better dependent on the edge value. On the off chance that cycle is discovered, at that point the bit determination is changed and gives the achievement bits. This procedure is helped inside each encryption and decryption process. At last, the information classification and information trustworthiness are accomplished because of the Ant Lion ideal nature of Ant's system.

V. CONCLUSION

In Wireless Sensor networks many outcomes are based on energy efficient and ensuring security aspects. The solution for security aspects are given by node capturing methods. This proposed method ensuring security aspect as well as energy consumption by selecting cluster head of all nodes, giving high success bit rate and low threshold value. The effective change of Ant's location makes their respective mechanism will update and links the node directly. This Ant Lion key management reducing the risk factor of data transmission losses and improving security based on management overhead

REFERENCES

1. Dr.J.R.Arunkumar, Chaotic African Buffalo Optimization Based Efficient Key Mechanism in Categorized Sensor Networks, International Journal of Engineering and Advanced Technology, Vol-9,Issue-3, February 2020.
2. Mirjalili, S. (2015). The ant lion optimizer. Advances in Engineering Software, 83, 80-98.
3. Yogarajan, G., & Revathi, T. (2016). A discrete ant lion optimization (DALO) algorithm for solving data gathering tour problem in wireless sensor networks. Middle-East Journal of Scientific Research, 24(10), 3113-3120.
4. Ali, E. S., Elazim, S. A., & Abdelaziz, A. Y. (2017). Ant Lion Optimization Algorithm for optimal location and sizing of renewable distributed generations. Renewable Energy, 101, 1311-1324.
5. Heidari, A. A., Faris, H., Mirjalili, S., Aljarah, I., & Mafarja, M. (2020). Ant Lion optimizer: theory, literature review, and application in multi-layer perceptron neural networks. In Nature-Inspired Optimizers (pp. 23-46). Springer, Cham.
6. Oliva, D., Hinojosa, S., Elaziz, M. A., & Ortega-Sánchez, N. (2018). Context based image segmentation using antlion optimization and sine cosine algorithm. Multimedia Tools and Applications, 77(19), 25761-25797.
7. Lin et al., (2016). ATPC: adaptive transmission power control for wireless sensor networks. ACM Transactions on Sensor Networks (TOSN), 12(1), 6.
8. Modieginyane (2018). Software defined wireless sensor networks application opportunities for efficient network management.
9. Pour et al., (2007). A hierarchical group key management scheme for secure multicast increasing efficiency of key distribution in leave operation. Computer Networks, 51(17), 4727-4743.
10. Abu-Mahfouz & Hancke (2018). Localized information fusion techniques for location discovery in wireless sensor networks.
May et al., (2015). Energy management in production: A novel method to develop key performance indicators for improving energy efficiency. Applied Energy, 149, 46-61.
11. Blum C, Puchinger J, Raidl GR, Roli A. (2011). Hybrid metaheuristics in combinatorial optimization: a survey. Apple Soft Compute; 11:4135–51.

12. Boussaïd I, Lepagnot J, Siarry P. (2013). A survey on optimization metaheuristics. Inform Sci; 237:82–117.
13. Gogna A, Tayal A. (2013). Metaheuristics: review and application. J Exp Theor Artif Intell; 25:503–26.
14. Bianchi L, Dorigo M, Gambardella LM, Gutjahr WJ. (2009). A survey on metaheuristics for stochastic combinatorial optimization. Nat Comput: Int J; 8:239–87.
15. Talbi E-G. (2009). Metaheuristics: from design to implementation, vol. 74. John Wiley & Sons.
16. Dr.J.R.Arunkumar, Dr.M.Sundarrajan," An Efficient Greedy Algorithm To Improve The Lifetime Of The Wireless Sensor Network" In CiiT International Journal Of Networking And Communication Engineering ISSN 0974 – 9616, Volume- 8, Issue-10, December 2016.
17. Dr. M. Sundar Rajan, Dr. J. R. Arunkumar Dr. R. Anusuya," Energy Efficient Cluster Head Selection In Adhoc on Demand Multipath Distance Vector Routing Protocol" in International Journal Of Scientific & Technology Research, ISSN 2277-8616, Volume 9, Issue 01, January 2020.
18. Dr. Arunkumar, J.R., Dr. SundarRajan M. And Dr. Anusuya, R.. 2020. "Energy Efficient Algorithm for Wireless Sensor Networks Based On Cluster Head", International Journal of Current Research, 12, (4), April-2020
19. Arunkumar, J.R., Anusuya, R., Sundar Rajan, M. et al. Underwater Wireless Information Transfer with Compressive Sensing for Energy Efficiency. Wireless Pers Commun (2020). https://doi.org/10.1007/s11277-020-07249-7

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