# Riloid-ACO SCHEME FOR WSN

M.Karpagam[1], P. Vinesha[2], S.Jayanthi Sree[3]

*[1]Professor, [2]PG Student , [3]Assistant Professor, Department of Electronics and Communication Engineering, Sri Krishna College of Engineering and Technology, Kuniamuthur, Coimbatore, Tamilnadu, India*

***Abstract***

*A Wireless Sensor Network is a collection of miniature devices known as Sensors that are intended for the purpose of sensing and sending data and information to the sink. They are used in various applications and in areas that require continuous monitoring such as military fields and medical cabins. The most critical issue or the important criteria regarding this WSN is energy conservation and lifetime maintenance. Although various clustering and routing mechanisms are proposed for WSNs, the problem remains unsolved and still it remains as a popular research topic. One such idea to improve the lifetime improvement is the effective usage of the isolated and dumb nodes in the network. Dumb nodes are different from the isolated ones. The nodes that continue sensing but unable to send the data is categorized as dumb nodes while the nodes that aren't included into clusters are called isolated nodes. We have proposed a method known as RILoID-ACO (Ant Colony Optimization enriched scheme for Reduction in information loss in the occurrence of Dumb and isolated nodes) that enables the practice of mobile mule in collecting the data from isolated and dumb nodes by enhancing a trust parameter. Success probability of 100 % and data loss protection over 19% is obtained as the result of simulation that shows the success of the proposed system.*

***Index terms***: *Wireless Sensor Network, WSN, isolated nodes, dumb nodes, RILoID, ACO, lifetime improvement.*

## INTRODUCTION

Wireless Sensor Network is an infrastructure-less structure that is self configurable and is used in monitoring of various physical and ecological conditions like humidity, sound, temperature, and pressure. Each WSN has a sink, source gateway and a cluster of sensor nodes. Based on the clustering methodology used, the sensor nodes form clusters and communicate within themselves by using radio signals. A sensor node consists of power supply, memory, microcontroller, sensor/actuator, and a transceiver that acts both transmitter and a receiver.

The sensor nodes have storage capacity and bandwidth for communication. At the moment they are employed, they self-configure themselves and based on the clustering, a cluster head is nominated. The deployed nodes are event driven or continuous in working. To obtain the information of the location and position of the sensor nodes, GPS is used.

When the cluster head of a cluster is elected, it broadcasts HELLO messages to the neighboring sensor nodes. In return the sensor nodes send REPLY message to the cluster head. All the information of the neighbor nodes are maintained in the table of the cluster head. The cluster head is the one that has highest threshold and more energy. It transforms the collected information to the sink directly. There are times when a sensor node is away from its head otherwise its communication range is not within the reach of the cluster head. Those senor nodes are identified as isolated nodes. Additionally, there are chances where nodes get detached from their clustered due to the

ISSN: 2233-7857 IJFGCN

environmental change. If a sensor node is affected by the climatic change, it gets detached from the cluster. That is, the particular node continues its sensing but fails to hurl the data to its head or the neighbor nodes. This type of separation is temporary. After a certain period, the connectivity gets established automatically when the favorable environment change occurs. But the issue with these isolated and dumb nodes is that, the data from them needs to be collected else there is high chance of losing the data. Another issue is that the isolated node increases its communication range to send its information to the neighbor nodes that result in extra energy consumption.

So, in this paper we have introduced a scheme called RILoID-ACO. ACO enriched scheme for Reduction in Information Loss in Isolated and Dumb nodes is proposed in this paper that uses mobile mule for collecting the data from the dumb and isolated nodes in a shortest path by enhancing a trust parameter.

## RELATED WORK

Various clustering and connectivity reestablishment techniques are proposed by research scholars for a Wireless sensor network. ReDAST is one such method that is used for effective data acquisition from the transfaulty nodes. According to the authors of [1], the temporary node segregation may lead to the communication holes in the network that result in information loss. To overcome this issue, the authors propose that each sensor node should have twin modes of communication such as RF and acoustic. The normal sensor node follows the RF mode and if gets affected by any of the radiation, the node gets changed to the acoustic mode and data fusion is used to gather information from those transfaulty nodes.

While [1] is intended for the transfaulty nodes, EEC-IN mechanism in [2] is proposed especially for the isolated nodes. Energy-Efficient Clustering technique with isolated node is based on the networking concept where during the clustering mechanism, it is said that each isolated node follows a membership handshaking process with that of the closer cluster head. It is proved that this method has reduced the network traffic and improved the lifetime too.

The data transfer is initiated by the isolated nodes in some cases. One such methodology is LECRAD and it is proposed in [3]. It is a Learning-Automata based Connectivity Reestablishment scheme where the isolated one sends the RREQUEST messages to the neighboring nodes. It waits for the RREPLY message from the nodes. If not received, it increases the communication range and sends the RREQUEST message again. The problem with this kind of mechanism is that it needs co-operation with all the neighbor nodes and every node needs to be active at the moment.

Unlike our proposed system, certain agents can also be used to gather the data from the isolated nodes. For example, the authors of [6] have proposed a method of data acquisition by mobile ferries.

It is proven that selection of Cluster head can also solve the issue of prevention of creation of isolated nodes. So, we have techniques like REAC-IN in [7], and Routing with Isolated node (RIN) in [8] that provides novel method of electing the cluster head and formation of clustered such that isolated nodes are not created.

## PROPOSED SCHEME

Both dumb and isolated nodes are temporary in nature. The idea of usage of mobile mules is already proposed by authors in RILoD scheme that is explained in [10]. The main issue of this scheme is the trust parameter to ensure that the particular node is actually isolated or not. To enhance a trust factor in the scheme, we have used the optimization technique ACO. The pheromone value calculation in the Ant Colony Optimization technique is used to provide a trust parameter and a shortest route for the mobile mule to reach the isolated node. There are various routing mechanisms based on ACO while [11], [12], and [13] are examples for it.

The framework or the phases included in RILoID-ACO scheme are:

**Neighbor discovery**: As the first step, when the nodes are deployed on the particular area, the parent node sends HELLO message to the one-hop neighbor. On the succession reception, the node in turn sends the REPLY message and accepts the previous node as the parent node. Similarly, HELLO messages are broadcasted and REPL messages are received in turn. After this process, the neighbor list is maintained by the parent node. The route developed by the nodes is stored by the sink in its routing table as TOPINFO. The helps the sink to develop the sleep activation schedule for the each route.

In case if the data from the particular node or route hasn't reached the sink, then the sink initiates the activation schedule for the particular route and ACO method is enhanced. As per this technique, HELLO message is transmitted from the parent node to the neighbor list. REPLY message is sent back to the Parent node and on the successive reception, the pheromone value is calculated using below formula:

$$\Delta\tau_{ij} = \begin{cases} 1/L & if\,(i,j) \in T^k \\ 0 & otherwise \end{cases} \longrightarrow (1)$$

Where,

$\Delta\tau_{ij}$= quantity of pheromone on each path,

$T^k$=tour done by ant k at iteration t,

L=length.

A memory $M^k$ is maintained in order to avoid the cycling of the same route or node. The flow of the proposed system is given in the form of a flow chart in Fig.1.

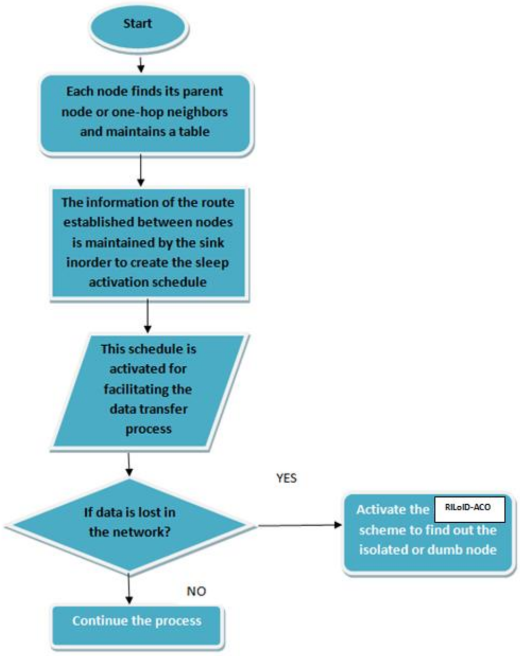


Fig.1. Flow chart for the proposed system

If the pheromone value of the particular node is detained as 0, then the particular node is conformed as isolated or a dumb node. The pheromone value is maintained in a table and with highest is given the highest priority as it has highest threshold.

**Routing of Mobile mule and data transmission**: Once the isolated node is identified, the information is given to the sink along with the pheromone value. The sink now feeds the information of the isolated and dumb nodes that are not reachable about the position, node ID, and location. It prepares the route for the mobile mule to travel within the network and such that it reaches the destination in a shortest path.

The mule now starts at the sink and reaches the nearest isolated node. Once it reaches the node, the particular node dumps the data within the mobile mule and delivers it to the parent node. It then travels towards the next destination. The process continues until the mule reaches all the destined isolated nodes.

**Route maintenance**: Once the mobile mule reaches the sink, the sink looks for the remaining isolated ones if any. If yes, it initiates the process again. If not, the mobile mule goes to sleep mode

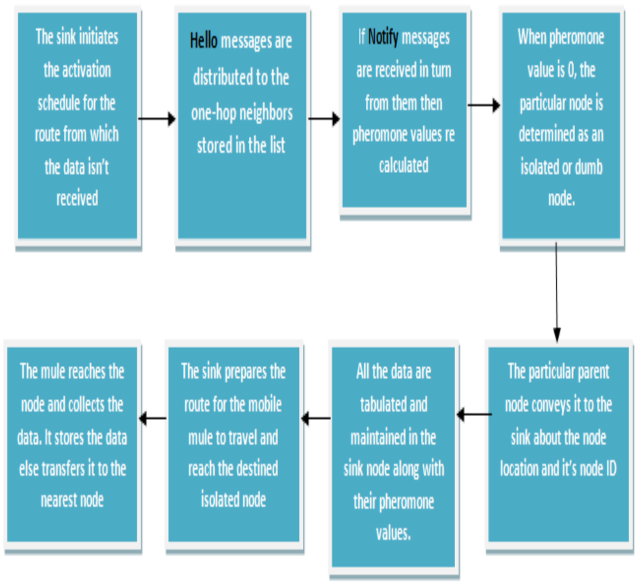


Fig.2. Block diagram of the RILoID-ACO scheme

## SIMUALTION RESULTS

When the proposed work is executed and simulated in NS3 tool, certain results can be obtained that are discussed here. As a first step, the node or network structure is created with 100 nodes. Nodes are assigned as source, sink and mule unlike Fig.3.

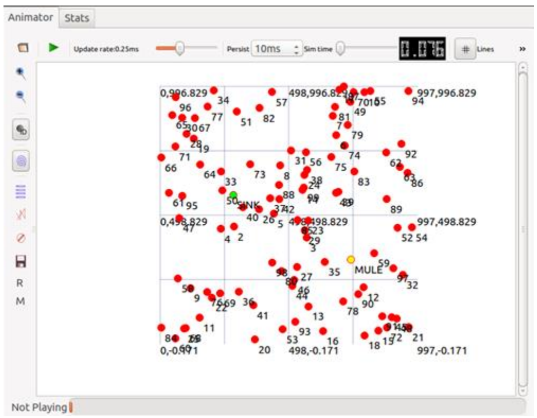


Fig.3. Network structure

We now assume a sensor node as an isolated node and the distance or coverage of the node from neighbor, sink, and mule is depicted in Fig.4.

ISSN: 2233-7857 IJFGCN

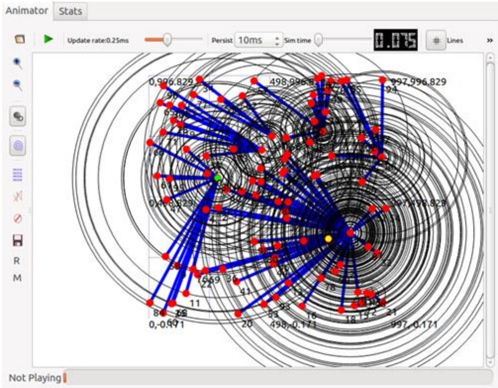


Fig.4. Coverage area depiction

Now, we gather the output in terms of data of the following interface for 100 sensor nodes.

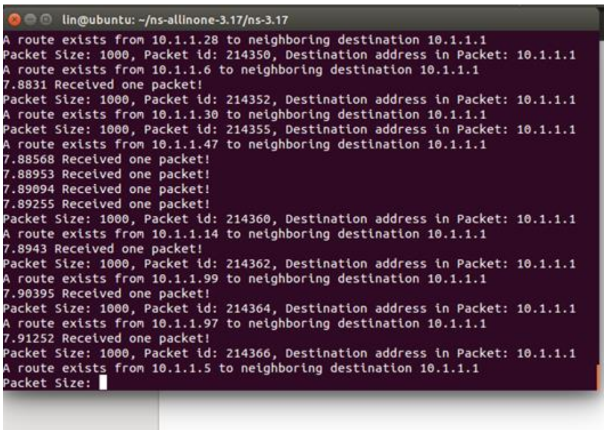


Fig.5. Output screen of the simulation

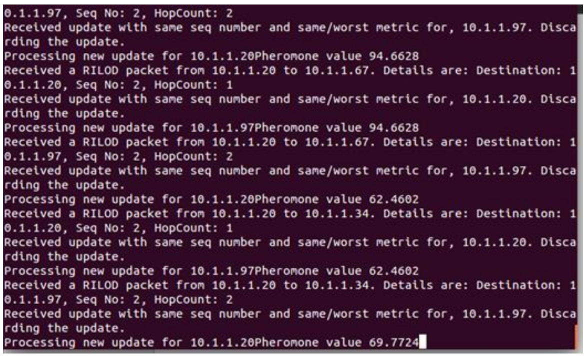


Fig.6. Output screen of the simulation

When Fig.6. Is observed carefully, it can be seen that pheromone is calculated for reach route based on transmission and reception of RILoD packet.

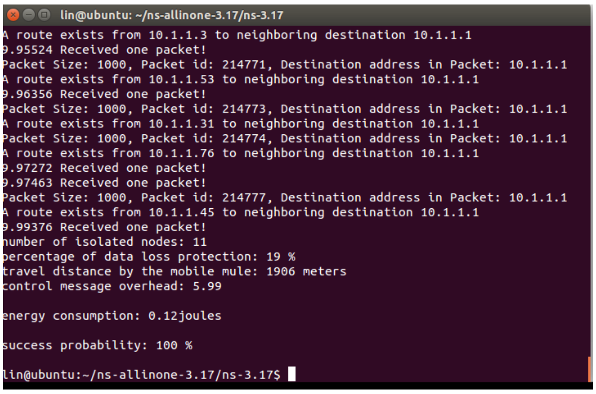


Fig.7. Output screen of the simulation

The output screen of the simulation is depicted in Fig.7. It can be found that we have obtained the success probability of 100% and the distance travelled by mobile mule is 1906 meters. The data loss protection is found to be 19%.

The obtained data can be transferred to the form of graph by in-built library function called Gnuplot in NS3.

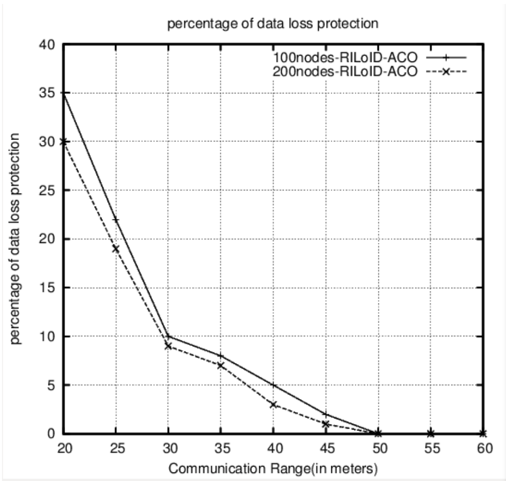


Fig.8. Percentage of data loss protection Vs communication range

The total energy consumed by the mule for 100 and 200 nodes is found to be 0.12 joules. When nodes are high, energy consumption is high as shown in Fig.8.

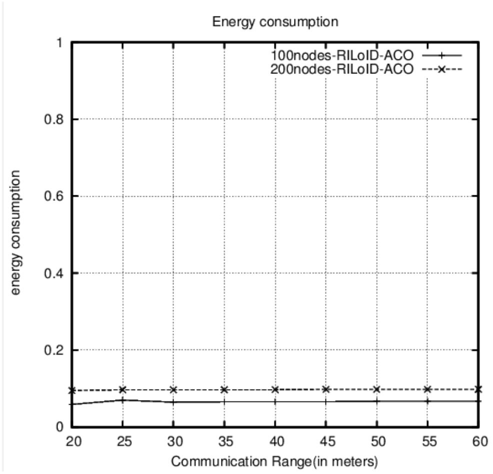


Fig.9. Energy consumption Vs communication range

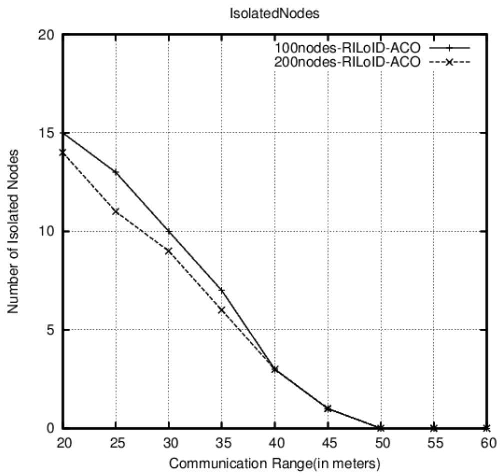


Fig.10. Isolated nodes Vs communication range

The isolated nodes based on communication range differ whereas for 100 nodes, the isolated nodes are high when compared to 200 nodes as shown in Fig.10.

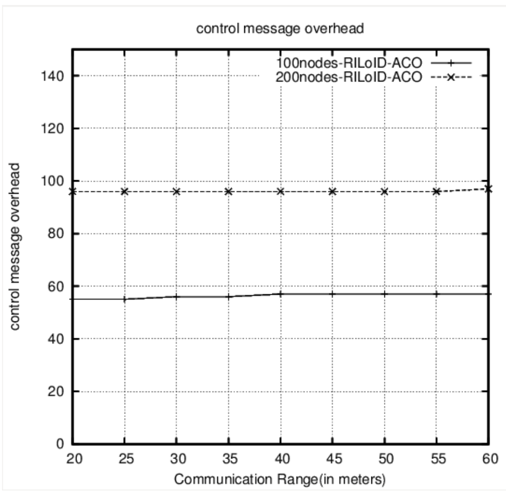


Fig.11. Control message overhead Vs communication range

In RILoID-ACO scheme, the control message overhead is low to the range of 5.99 when 100 nodes are considered.

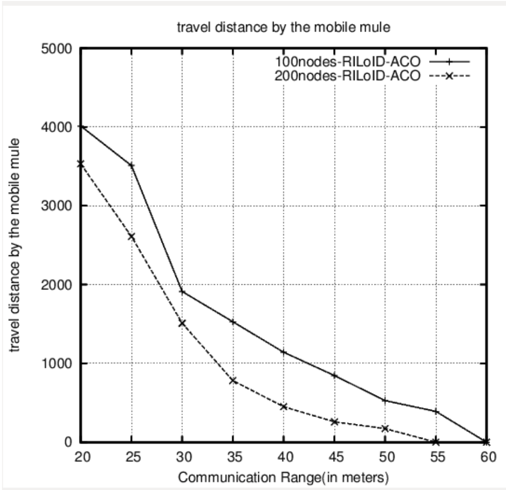


Fig.12. Distance covered by the data mule Vs communication range

The entire distance covered by data mule is based on the communication range and node range. When the range and node concentration increases, the distance decreases as shown in Fig.12.

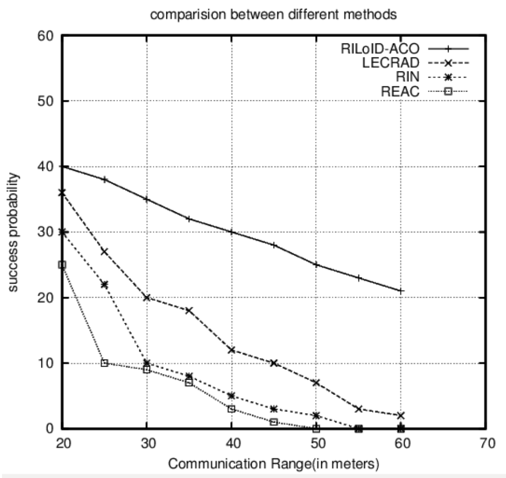


Fig.13. Comparison in success probability between RILoID-ACO and other related methods

Fig.13 depicts the comparative analysis of the proposed system and LECRAD, REAC, and RIN algorithm that deals with cut off nodes too.

## CONCLUSION AND FUTURE WORK

Within the scope of the paper, we have discussed the range of techniques that are extant for effective data transfer and lifetime conservation by means of isolated nodes. Additionally, we have proposed a method known as RILoID-ACO, which utilizes data mules to gather sensed data from the dumb and isolated nodes. From the simulation results of the projected method, 19% of data loss protection has been achieved along with 100% success probability. The scheme proves to be successful and as a future work, the steps to improve data loss protection can be undertaken. Further, the process is carried out in a simulator tool and hence if carried out in a real Testbed, various other factors and improvements can be observed…

## REFERENCES

[1] Karpagam M, Prabha D. (2019). "**Underwater Wireless Sensor Network Based Marine Environment Monitoring System**". *International Journal of Oceans and Oceanography*, vol 13, Number 2(2019), pp.269 – 276.

[2] Karpagam M, Thirumarai Selvi C. (2018). "A Relay Node Routing Technique to HEF clustering Algorithm for Time Critical Wireless sensor Networks". *In International Journal of Pure and Applied Mathematics* vol 119, Issue 12, pp. 1373 - 1384.

[3] Karpagam M, Nagarajan N, Abiramiatavi J(2014). **"An Energy efficient Enhanced Error Node Regaining Algorithm for a Wireless Sensor Network**." *In Journal of Theoretical & Applied Information Technology* vol 61. No.2.

[4] Karpagam M, Nagarajan N, Vijaya Priya K (2014) "**Improving Wireless Sensor Network Lifespan through Energy Efficient Algorithms**" *In Journal of Theoretical & Applied Information Technology* vol 61. No.2

[5] Roy, A., Mondal, A., & Misra, S. (2014, December). "**Connectivity re-establishment in the presence of dumb nodes in sensor-cloud infrastructure: A game theoretic approach**". In *2014 IEEE 6th International Conference on Cloud Computing Technology and Science* (pp. 847-852). IEEE.

[6] Mikhaylov, Konstantin, and Jouni Tervonen. "**Data collection from isolated clusters in wireless sensor networks using mobile ferries**." *2013 27th International Conference on Advanced Information Networking and Applications Workshops*. IEEE, 2013.

[7] Chiang, T. H., & Leu, J. S. (2014, September). "**Regional energy aware clustering with isolated nodes in Wireless Sensor Networks**". In *2014 IEEE 25th Annual International Symposium on Personal, Indoor, and Mobile Radio Communication (PIMRC)* (pp. 1829-1833). IEEE.

[8] Karpagam M, Nagarajan N, Abiramiatavi J, Vijaya Priya K,(2014). "Analysis of EMCA, EFNR, and HEFRN Algorithm in Wireless Sensor Networks." *Int. conference on Applied Mechanics and Material*, vol.550, pp.102 - 109 .

[9] Vrince Vimal, Madhav J Nigam. "**Estimation of Optimum Rendezvous Point for Mobile Sink (ORP-MS) in WSN**." International Journal of Engineering &Technology, 7 (3.12) (2018) 1322 -1328.

[10] Kar, P., Misra, S., & Obaidat, M. S. (2018). "**RILoD: Reduction of Information Loss in a WSN System in the Presence of Dumb Nodes**". *IEEE Systems Journal*, *13*(1), 336-344.

[11] Aripriharta, Hendrick, et al. "**OPPA-AC: Optimal Path Planning based on Ant Colony Algorithm for Temporary Isolated Node in WSN**." *Proceedings of Engineering and Technology Innovation* 2 (2016): 26.

[12] Iwendi, C., Zhang, Z., & Du, X. (2018, February). "**ACO based key management routing mechanism for WSN security and data collection**". In *2018 IEEE International Conference on Industrial Technology (ICIT)* (pp. 1935-1939). IEEE.

ISSN: 2233-7857 IJFGCN

[13] Huang, P., Kang, Z., Liu, C., & Lin, F. (2016, December). “**ACO-based path planning scheme in RWSN**”. In *2016 10th international conference on software, knowledge, information management & applications (SKIMA)* (pp. 237-242). IEEE.

[14] Vaishali, G., & Nighot, M. K. (2016, August). “**An efficient ACO scheme for mobile-sink based WSN**”. In *2016 International Conference on Inventive Computation Technologies (ICICT)* (Vol. 3, pp. 1-5). IEEE.

[15] Jukuntla, Amar, Keerthi Pendam, and N. Arjun. "**SAWR: Scheduling algorithm for wireless sensor networks with rendezvous nodes**." *2015 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*. IEEE, 2015.

ISSN: 2233-7857 IJFGCN