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An Improved LEDIR Technique Using LEDIR For Failure Node Recovery In WSN

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Abstract:
In this paper, node recovery techniques in Wireless Sensor Networks have studied and an improved node recovery algorithm has developed. LEDIR algorithm has studied and then a new I-LEDIR (improved LEDIR) algorithm has developed and also has compared with previous LEDIR and RIM. The new algorithm is compared to existing algorithms based on three parameters: distance moved, no. of nodes moved and total no. of messages exchanged and the results are presented.

***Keywords**: Wireless sensor network, Failure nodes, Node recovery, LEDIR, RIM.*

I. INTRODUCTION

In recent years wireless sensor and actor networks are gaining growing interest because of their suitability for mission critical applications that require autonomous and intelligent interaction with the environment. Examples of these applications include forest fire monitoring, disaster management, search and rescue, security surveillance, battlefield reconnaissance, space exploration, coast and border protection, etc. WSNs consist of numerous miniaturized stationary sensors and fewer mobile actors. The sensors serve as wireless data acquisition devices for the more powerful actor nodes that process the sensor readings and put forward an appropriate response. For example, sensors may detect a fire and trigger a response from an actor that has an extinguisher. Robots and unmanned vehicles are example actors in practice. Actors work autonomously and collaboratively to achieve the application mission. Given the collaborative actors operation, a strongly connected inter-actor network topology would be required at all times. Failure of one or multiple nodes may partition the inter-actor network into disjoint segments. Consequently, an inter-actor interaction may cease and the network becomes incapable of delivering a timely response to a serious event. Therefore, recovery from an actor failure is of utmost importance. The remote setup in which WSANs often serve makes the deployment of additional resources to replace failed actors impractical, and repositioning of nodes becomes the best recovery option. Distributed recovery will be very challenging since nodes in separate partitions will not be able to reach each other to coordinate the recovery process. Therefore, contemporary schemes found in the literature require every node to maintain partial knowledge of the network state. To avoid the excessive state-update overhead and to expedite the connectivity restoration process, prior work relies on maintaining one- or two-hop neighbor lists and predetermines some criteria for the nodes involvement in the recovery. Fault tolerance is the ability to maintain sensor networks functionalities without any interruption due to sensor nodes failure.

II. LITERATURE REVIEW

In this paper [1] an advance in microelectronic fabrication technology reduces the cost of manufacturing portable wireless sensor nodes. It becomes a trend to deploy the large numbers of portable wireless sensors in WSNs to increase the quality of service (QOS). The QOS of such WSNs is mainly affected by the failure of sensor nodes. Probability of sensor node failure increases with increase in number of sensors. In order to maintain the better QOS under failure conditions, identifying and detaching such faults are essential. In the proposed method, faulty sensor node is detected by measuring the round trip delay (RTD) time of discrete round trip paths and comparing them with threshold value. Initially, the suggested method is experimented on WSNs with six sensor nodes designed using microcontroller and Zigbee. Scalability of proposed method is verified by simulating the WSNs with large numbers of sensor nodes in NS2. The RTD time results derived in hardware and software implementations are almost equal, justifying the real time applicability of the investigated method. Generalized time model derived is best suited to determine the fault detection analysis time for any combination of m and N sensor nodes in WSNs. The use of discrete RTPs in the proposed method has enhanced the efficiency of fault detection. In future work, we are implementing and testing the performance of suggested methods with different topologies of WSNs like triangular, rectangular and NJ-LATA. This will be useful to validate the complexity and applicability of investigated method to various types of WSNs.

In this paper [2] it is discussed that over its lifetime, a Wireless Sensor Network (WSN) loses connectivity as more and more of its battery-powered nodes fail. In this paper, we study how to repair such a network by the gradual deployment of new sensor nodes. We provide algorithms that not only economically adjust the number of replaced nodes but also improve the network by placing the new nodes in better locations. This new approach substantially increases the lifetime of the repaired WSN compared to replacing all nodes at their old positions. Deploying new sensor nodes can be a cost-efficient solution to repair operating WSNs and can lead to considerable improvements in network lifetime if the new locations are carefully chosen. This paper has presented a heuristic approach for conducting this type of network repair that succeeds in significantly extending network lifetime.

The author in this paper [3] Wireless sensor networks (WSNs) facilitate monitoring and controlling of physical environment from remote location with better accuracy. They can be used for various application areas (e.g. Health, military, home). Due to their unique characteristics, they are offering various research issues that are still unsolved. Sensors energy cannot support long haul communication as changing energy supply is not always possible in WSN. Also, failures are inevitable in wireless sensor networks due to inhospitable environment and unattended deployment. Therefore fault management is an essential component of any network management system. In this paper we propose new fault management architecture for wireless sensor networks. In our solution the network is partitioned into a virtual grid of cells to support scalability and perform fault detection and recovery locally with minimum energy consumption. Specifically, the grid based architecture permits the implementation of fault detection in a distributed manner and allows the failure report to be forwarded across cells. A cell manager and a gateway node are chosen in each cell to perform management tasks. We divided the network into a virtual grid, where each cell consists of a group of nodes. This supports scalability of the network and increase network life time. Most of existing solution used some type of central entity to perform fault management tasks but in our proposed solution, the aim is to perform fault detection locally and in distributed fashion. Unlike clustering, it is based on homogenous paradigm where nodes are of equal resources and can easily back up each other in case of recovery.

In this paper [4] the author has explained the necessity of autonomous nature of nodes in unattended atmosphere as advancement of wireless sensor network in the field of disaster management, border protection, and combat field reconnaissance and security surveillance. Failures of nodes are in such applications cause the communication stop and in such conditions during unavoidable situation it is difficult to search the faulty node. So it is required to detect the node which has power failure. In this paper a new mechanism is prepared to sustain the network operation to detect the node. The grid based architecture is implemented in virtual way as it permits the detection of node and transmits its information cell by cell to destination.

These research paper [5] actors collaboratively respond to achieve predefined application mission. Since actors have to coordinate their operation, it is necessary to maintain a strongly connected network topology at all times. Moreover, the length of the inter-actor communication paths may be constrained to meet latency requirements. However, a failure of an actor may cause the network to partition into disjoint blocks and would, thus, violate such a connectivity goal. One of the effective recovery methodologies is to autonomously reposition a subset of the actor nodes to restore connectivity. Contemporary recovery schemes either impose high node relocation overhead or extend some of the inter-actor data paths. This paper overcomes these shortcomings and presents a Least-Disruptive topology Repair (LEDIR) algorithm. LEDIR relies on the local view of a node about the network to devise a recovery plan that relocates the least number of nodes and ensures that no path between any pair of nodes is extended. LEDIR is a localized and distributed algorithm that leverages existing route discovery activities in the network and imposes no additional pre-failure communication overhead. This paper has tackled an important problem in mission critical WSNs, that is, re-establishing network connectivity after node failure without extending the length of data paths. We have proposed a new distributed LEDIR algorithm that restores connectivity by careful repositioning of nodes. LEDIR relies only on the local view of the network and does not impose pre-failure overhead. The performance of LEDIR has been validated through rigorous analysis and extensive simulation experiments. The experiments have also compared LEDIR with a centralized version and to contemporary solutions in the literature. The results have demonstrated that LEDIR is almost insensitive to the variation in the communication range. LEDIR also works very well in dense networks and yields close to optimal performance even when nodes are partially aware of the network topology.

III. PROBLEMS IN CURRENT WORK

1. Topology of the network is not optimized with respect to the area to be covered. Hence iteration frequency of every node varies with respect to network affinity.
2. Non critical nodes are consumed minimum till the extinction of the network.

3. No Classification of criticality of node is provided in the network.

IV. PROPOSED WORK

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1. The network will be gridded and actor nodes will be covering critical regions of the network. This will prevent the node failure in the network by optimizing the consumption throughout of the network.
2. A critical node chart will be developed and nodes with least criticality in the current topology will be used to do the most iteration in the network.
3. RIM & LEDIR comparison will be done on the basis of :
   a. **Number of nodes :** A table will be plotted for both algorithms and number of node movements will be calculated and compared for efficiency in network
   b. **Distance moved by nodes:** A table will be calculating the displacement of the actor node differently for critical and non critical nodes. This will help to determine the algorithm to make minimum topology change in network.
   c. Calculating total messages exchanged : In this we will calculate the total messages exchanged in the network. And this will help us to calculate the life and efficiency of the network.

In this research work we are going to design a new algorithm with two main concerns:

1. Minimizing the node failure in network.
2. Node recovery if in case any node fails.

In this research we will design algorithm which will analyze the network and categorize it as follows:

1) Critical Sectors

In this part we will analyze the sectors which can get disconnected if one or more than one node fails.

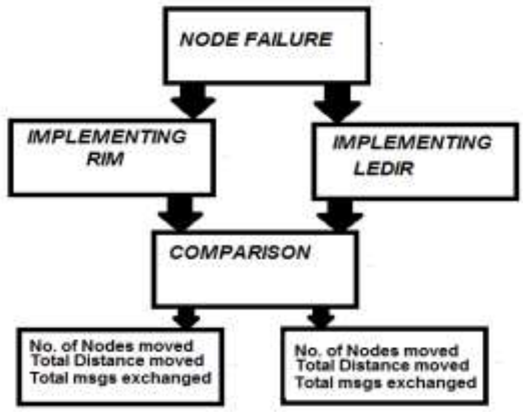
2) Critical nodes

In this we will analyze the nodes which are going to have maximum load on them during communication. These nodes are the most important nodes as they will be handling most of the communication in the network.

3) Criticality Chart

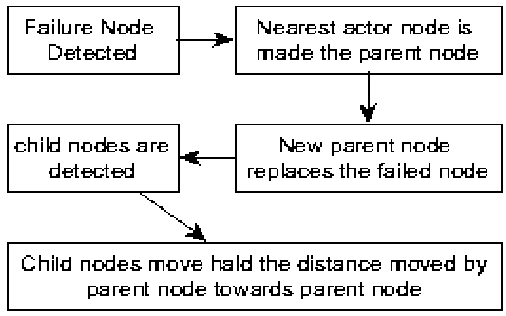
Criticality chart will be a data base of the critical nodes and sectors in the increasing order of their criticality.

4) Above three factors will help us to determine most failure prone networks and we will deploy one or more actor node in these regions to prevent the failure of the network.

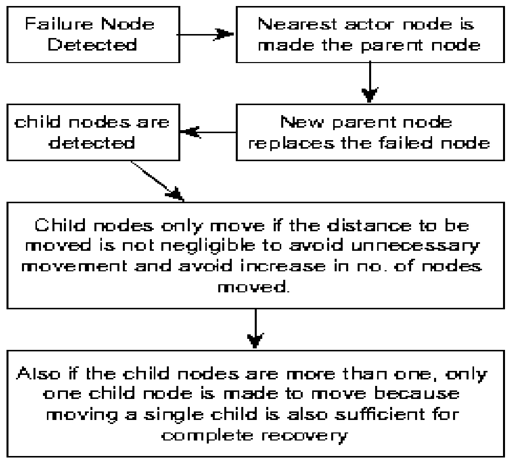


V. METHODOLOGY

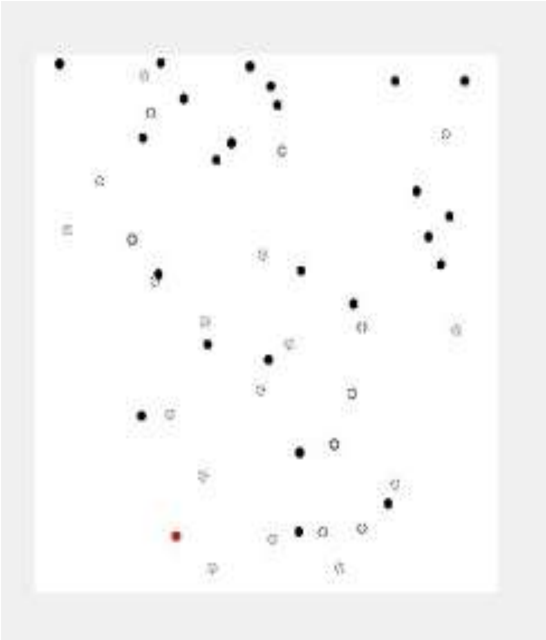
Methodology of LEDIR



Methodology of I-LEDIR

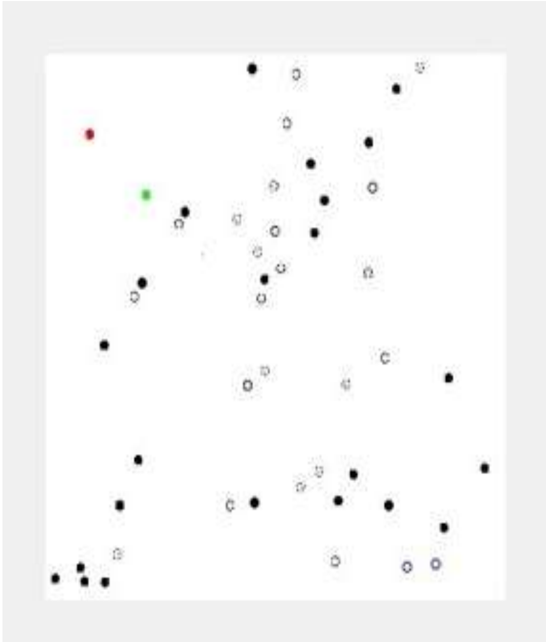


VI. EXPERIMENT AND RESULTS

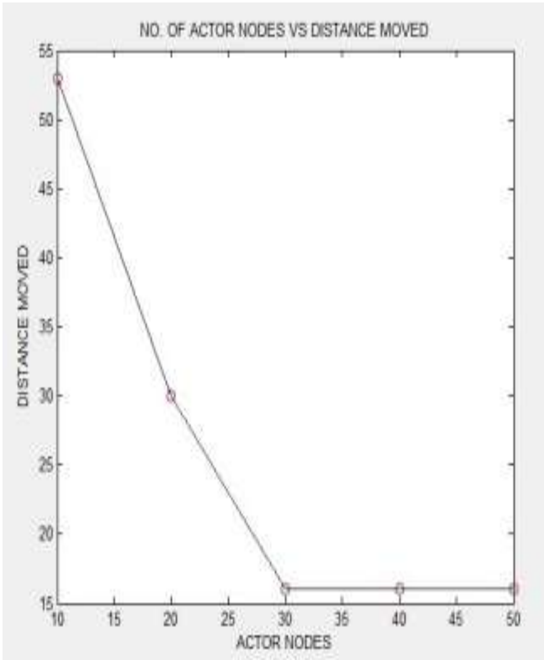


To start with the LEDIR button, this will show us number of nodes and the red one showed in the figure is the failure node which is recovered.

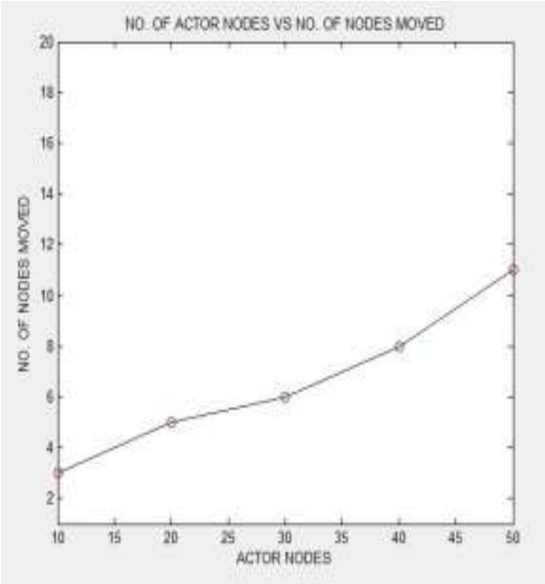
In case of RIM button red is the recovered node and when the node is recovered then rest of the network shifts.



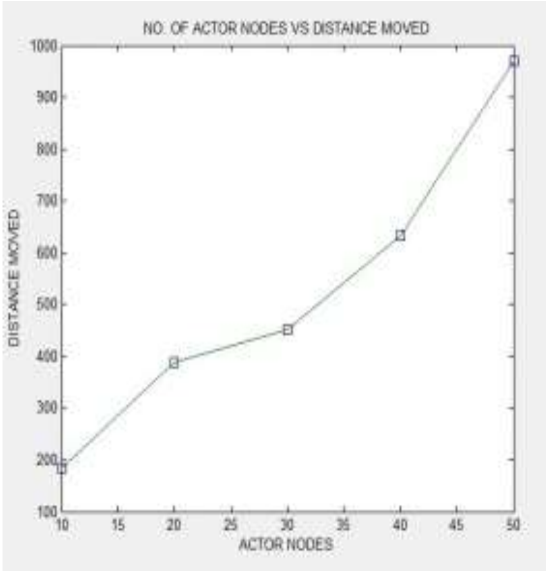
This I-LEDIR, where ‘I’ stands for “improved”. This I-LEDIR is similar to the LEDIR but over the difference is that only the recovered node move and result of the network do not change its place.



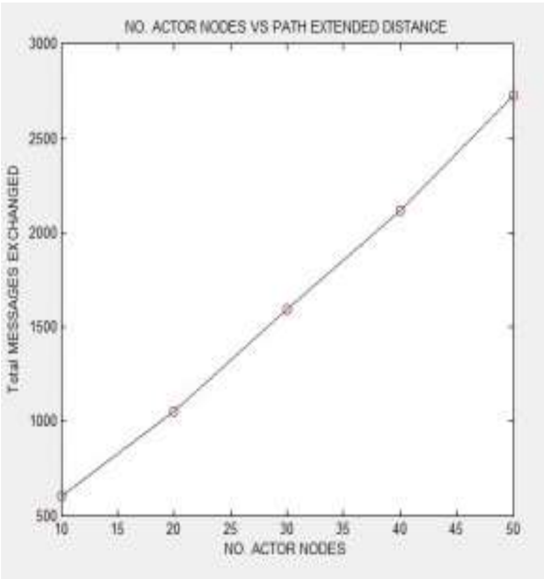
First is the LEDIR coulomb, figure shows the subdivided button in the LEDIR .We over here have plotted the distance graph. This graph is plotted against actor node.



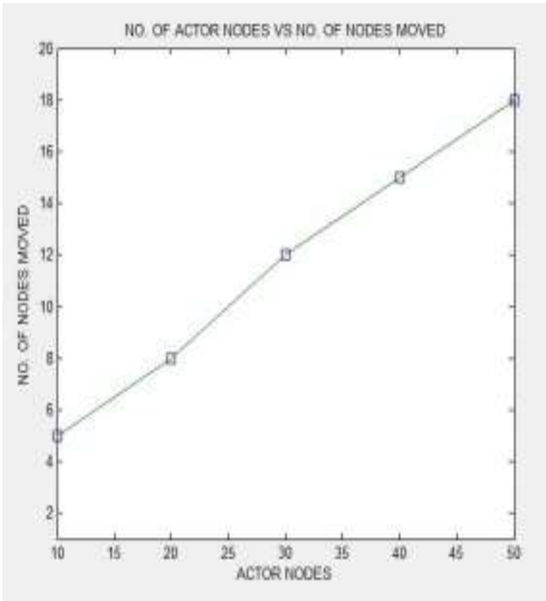
This figure shows that when we click on "number of nodes plot" of LEDIR this above shown graph is the one which is between the actor nodes and number of nodes moved.



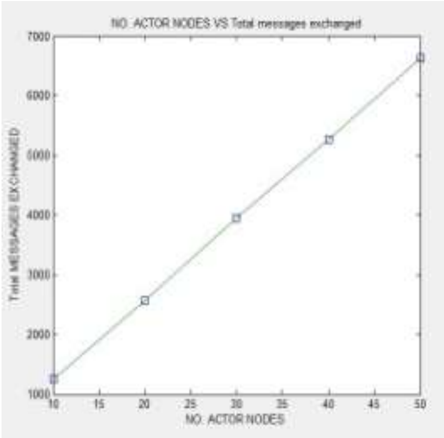
This figure shows the subdivided button in the RIM .We over here have plotted the distance graph. This graph is plotted against actor node.



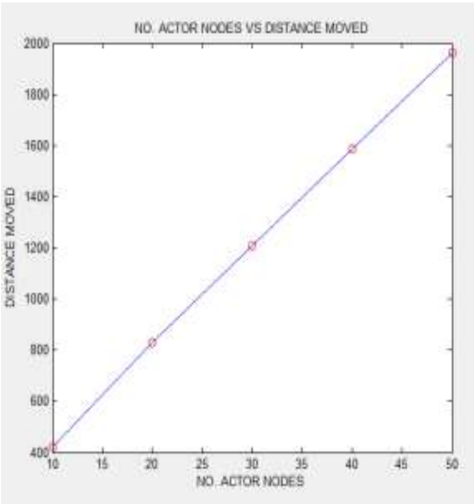
This figure shows the "total message exchanged" button of LEDIR and the graph is plotted between number of actor nodes and total number of messages exchanged.



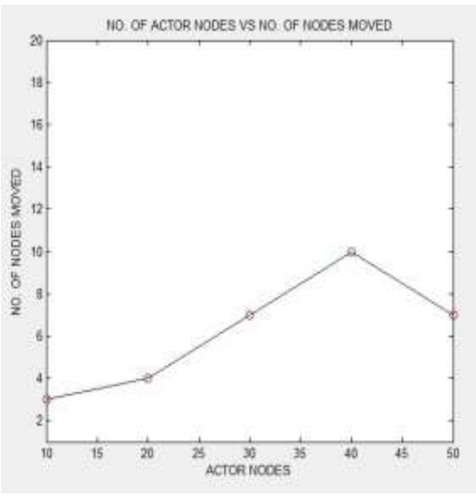
This figure shows that in RIM when we click on "number of nodes plot", this above shown graph is showed and this plotted between the actor nodes and number of nodes moved.



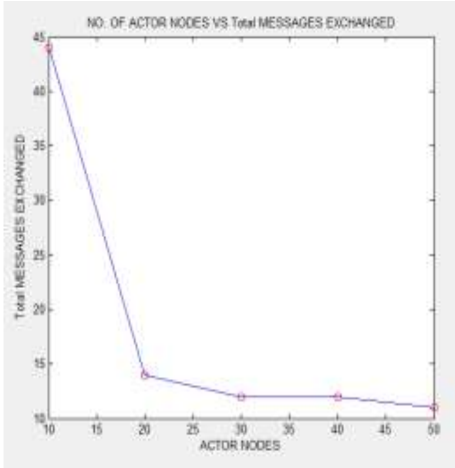
This figure shows the "total message exchanged" button in RIM and the graph is plotted between number of actor nodes and total number of messages exchanged.



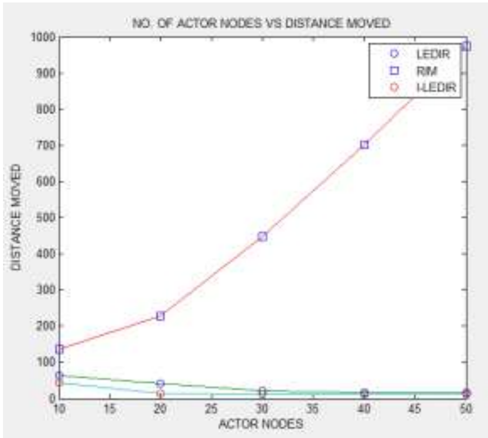
This figure shows the subdivided button in I-LEDIR .We over here have plotted the distance graph. This graph is plotted against actor node.



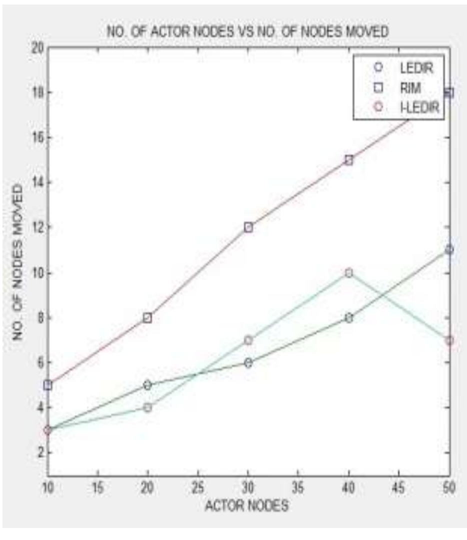
This figure shows that when we click on "number of nodes plot" of I-LEDIR this above shown graph is showed and this plotted between the actor nodes and number of nodes moved.



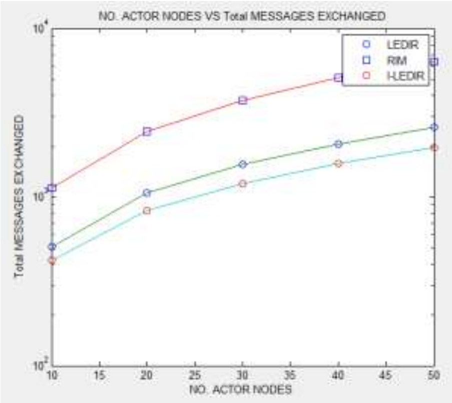
This figure shows the "total message exchanged" button of I-LEDIR and the graph is plotted between number of actor nodes and total number of messages exchanged.



Next is the comparison coulomb, this graph is between actor nodes and the distance moved by nodes, so the less distance moved is by the I-LEDIR, which shows the best results.

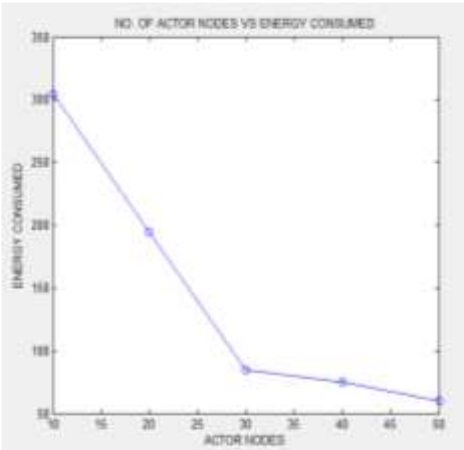


This figure shows that when we click on "number of nodes plot", this above shown graph is the one which is between the actor nodes and number of nodes moved. Among LEDIR, RIM and I-LEDIR, I-LEDIR shows the better results.

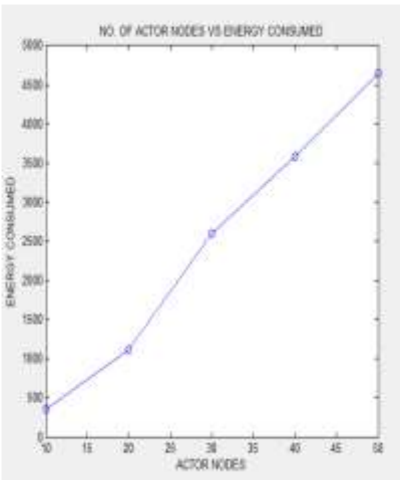


This graph shows how much total number of messages are exchanged and I-LEDIR exchange lesser number of messages than LEDIR and RIM.

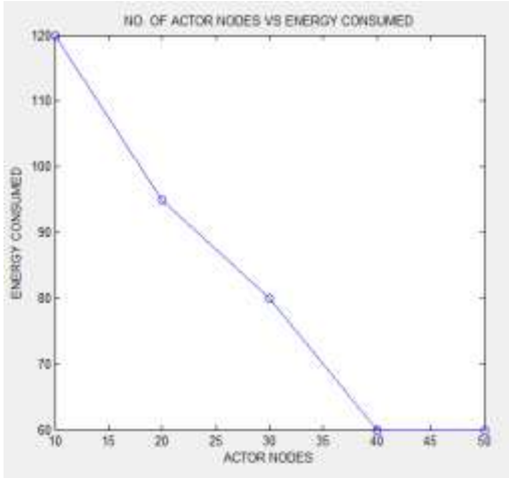
Energy Consumption:



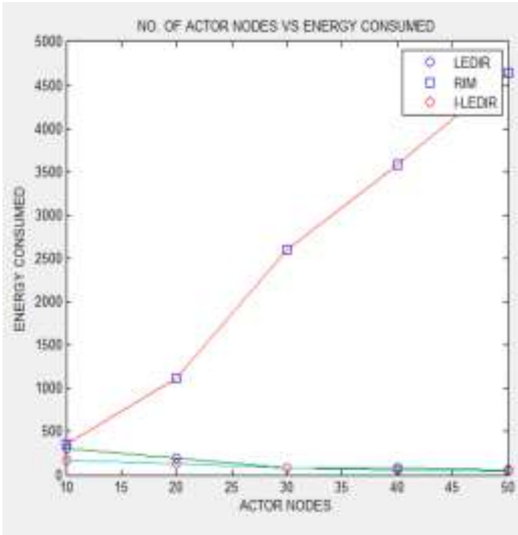
Energy Consumed in LEDIR. This figure shows the energy consumed over number of nodes in LEDIR system.



Energy Consumed in RIM. This figure shows the energy consumed over number of nodes in RIM system.



Energy Consumed in I-LEDIR. This figure shows the energy consumed over number of nodes in I-LEDIR system.



Comparison of Energy Consumed. In this figure, a comparison of the total energy consumed versus number of actor nodes, is plotted for all the three techniques, LEDIR (in blue circle), RIM (in blue square) and I-LEDIR (in red circle) thus plotting a comparison of the three. I-LEDIR consumes less energy between three.

VII. CONCLUSION AND FUTURE SCOPE

In wireless sensor networks it is very important to maintain the connectivity to ensure the reliability of the network so that they can be used in various fields like wars monitoring surveillance etc. Also there are several reasons for breaking of these networks in like physical changes, climatic damages or battery. It becomes crucial to repair this node failure and recover from the situation where some part of covering area gets out of control and sight of the networks. Also information flow gets heavily affected by this. So in this Paper after studying LEDIR algorithm and how it is when compared with RIM a new algorithm I-LEDIR is made. Two algorithms are compared on the basis of three parameters: No of nodes moved, total distance moved and total messages exchanged. I-LEDIR prove better in all parameters also I-LEDIR consumes lesser energy or battery power than LEDIR and RIM.

The current system is developed for a single node failure recovery. In the future, the concept can be extended to handle multiple node failure recoveries simultaneously too.

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