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Non Partitioning Node Failure Recovery in WSAN

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ABSTRACT

Remote sensor and movable systems (WSANs) allude to a gathering of sensors and movable actors connected by remote medium to perform conveyed detecting and activation assignments. In this paper, an enhanced DPCRA convention has beeen made which performs superior to the past base convention DPCRA. The improved DPCRA in addition to the partition nodes also recovers the non-partitioning nodes very smartly.

Keywords: WSAN, Node Recovery, DPCRA

I. INTRODUCTION

Wireless sensor actor networks is a group of interlinked sensor and actors in a network which performs various number of tasks depending on the type of sensor and actor used in the modern day technical assist systems. Because of their nature of being wireless they give the advantage of deploying them in remote areas where human intervention is restricted or is difficult to achieve. With the advantage of deployment far away these networks also bring the maintenance problems because often they are deployed in area where minimum human interaction is present to take care of them. For this purpose in maintaining the network connectivity becomes very important in case of any failure in the network, in which some node or more than one node stops performing due to battery rundown or any other natural or technical reason. To solve this problem some actors are deployed. Actors are node which are movable and are capable of recovering a failed node. In this connection, the importance of the term actor contrasts from the more ordinary idea of actuator. An actuator is a gadget to change over an electrical control sign to a physical activity, and constitutes the system by which a specialist follows up on the physical environment. From the point of view considered in this anticipate, in any case, a actor, other than having the capacity to follow up on the earth by method for one or a few actuators, is likewise a system element that performs organizing related functionalities, i.e., get, transmit, process, and transfer information. For instance, a robot may associate with the physical environment by method for a few engines and servo-instruments (actuators).

DPCRA is pertinent to haphazardly conveyed WSANs in dangerous situations where the recuperation of divided system is a major test. Upon sending, a self-instated eliminate is conveyed by the hubs in the system and every performing artist hub telecast a welcome message having Node Id and area data to its neighbor hubs (i.e. the performer hubs are the spine hubs of the system). To adapt to element changes in the system, a pulse message is sent occasionally by all the on-screen character hubs to overhaul data. On the off chance that any performing artist hub does not hear pulse message from its neighboring hub, then the disappointment of that specific hub is affirmed and assigned FH will begin the recuperation activity quickly.

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II. LITERATURE REVIEW

There is a lot of work done in WSANs to get a completely connected and secure network so that, a successful implementation and complete working of the network is posssible.

Akyildiz *et al.* [1] has discussed about the various research challenges that occur when nodes either sensor or actor try to coordinate and communicate with each other in wireless sensor and actor networks. They have looked into the various sensor – actor and actor- actor coordinations possible so that, wireless sensor and actor network work efficiently.

Younis and Akkaya [2] has emphasized on the strategies and techniques of node placement in wireless sensor network. They have classified the node placement strategies into static and dynamic depending upon whether the optimization calculation is evaluated at the time of deployment or when the network is in use, respectively.

Ameer *et al.* [3] has proposed DARA, a Distributed Actor Recovery Algorithm, which chooses to effectively reestablish the accessibility of the between interactor network that has been influenced by the breakdown of an actor node. The thought is to recognize minimal arrangement of actors that ought to be repositioned keeping in mind the end goal to build up accessibility among disjoint system segments. DARA endeavors to limit the extent of the healing procedure and minimize the development overhead forced on the included actors. DARA do not offer any method to identify cut vertices. DARA increases the maximum movement distance of all individual actors as the selection of failure handlers to replace the failed node is based on the neighbors'degree which further leads to more energy consumption of the network.

Akkaya *et al.* [4] has proposed a Connected Dominating Set (CDS) based partition recognition and healing algorithm. The thought is to recognize whether the breakdown of a hub or node causes dividing or not ahead of time. In the event that a dividing is to happen, the calculation assigns one of the neighboring hubs to start the accessibility rejuvenation process. This procedure includes repositioning of an arrangement of actors with a specific end goal to reestablish the network. The general objective in this rebuilding procedure is to confine the extent of the recuperation and minimize the development overhead forced on the involved actors.

Akkaya *et al.* [5] has proposed new distributed partition detection and recovery algorithm i.e. PADRA and PADRA+ to handle the connectivity crisis through recognition of possible partitions after the breakdown of the cut – vertex node is observed in the arrangement and re-establishes connectivity through controlled replacement of the movable nodes. The plan is to recognize the nodes in advance that will lead to partitioning in the arrangement. PADRA also does not offer any method to distinguish cut – vertices and non – cut vertices in the network. The authors have also presented a second distributed algorithm, PADRA+ which analyzes cut – vertex and non – cut vetex in advance to breakdown of the nodes by means of Dynamic Programming (DP). The authors have also presented another algorithm MPADRA to handle two nodes failure with the negligible overhead on the concerned nodes. However, Younis et al. [6] has claimed that MPADRA does not handle entirely separated divisions.

Younis *et al.* [6] has proposed a localized distributed algoritthm called Recovery through Inward Motion (RIM), in which the whole neighbor nodes move towards inward direction of the failed node with the intention of nodes can find out each other and recuperation can take place. RIM decreases the communication overhead by keeping only 1 – hop neighbor data. However, due to large number of nodes moves, the complete topology of the network gets distrupted leading to the coverage issues.

Ameer *et al.* [7] has proposed Least Disruptive topology Repair (LeDiR) algorithm, which depends on the neighborhood perspective of a node about the system with a specific end goal to devise a recovery plan that reposition minimal number of nodes and guarantees that no route between any pair of nodes is extened. LeDiR is a limited and distributed algorithm that influences existing path revelation activities and forces no more prefailure messages overhead. LeDiR consumes more energy of the network as large number of nodes movement occurs and also due to the calculation done at the time of recovery.

Abbasi *et al.* [8] has proposed a localized and distributed algorithm called Least Movement Topology Restoration (LeMoToR), which utilize the existing route discovery activities to know the existing topology of the network and take appropriate action accordingly. LeMoToR applies recursively on every node of a particular path to sustain the intra – smallest block connectivity. LeMoToR consumes specific amount of energy at the time of recovery as large amount of compuatation is done at the time of recovery.

Alfadhly *et al.* [9] has proposed a Least Distance Movement Recovery (LDMR) algorithm, is a disseminated approach that utilize non cut- vertices actor in the healing procedure. The thought is for set of nearest neighbours of the failed node to move toward the position of the failed node while its original location is replaced with the nearby non cut – vertex actor. In LDMR, a huge amount of communication overhead occurs on each node which consumes more energy leading to the decrease in the lifetime of the network.

V. Ranga *et al.* [10] has proposed a confined hybrid clock based cut-vertex hub disappointment recuperation approach called Distributed Prioritized Connectivity Restoration Algorithm (DPCRA) to handle such segments and reestablish availability with the assistance of a little number of movements. The primary thought is to proactively recognize whether the disappointment of a performing node hub causes partition or not in the system. On the off chance that segment happens to the assigned disappointment handlers recognize that partition and repair it locally utilizing least data put away as a part of every performer actor hub.

III. PROBLEM FORMULATION

The existing DPCRA algorithm only considers those nodes as critical failures which can partition the network for recovery process i.e. if a critical node fails. In such case, the other problems that may arrive are the cases of those nodes which might not partition the network but their failing will affect the communication between nodes to which that node was acting as relay for. The loss of such a node will increase the distance of communication between those nodes leading to high energy consumption which will lead to a very high probability of failure of those node too. Thus by considering only the critical nodesfor the recovery process, creates an uneven energy distribution throughout the network causing high node failures due to energy depletion.

Therefore, a node recovery algorithm is proposed which looks after all node failures as critical failure but tends to follow different node recovery steps in the two cases. In case of critical node failure, the recovery algorithm will recover the whole node as proposed by DPCRA. In case of non-critical node failure, the algorithm will find the minimum number of node movement in order to compensate for the coverage loss and communication loss.

IV. PROPOSED WORK

In DPCRA, only the partitioning nodes were being recovered which further decreased the durability of the network since the non-partitioning nodes which are not recovered created further network gaps which forces the alive nodes to transmit a higher distance which in turn burns the battery out quickly enough to become a prime reason node failure reason in the network further reducing the performance of the network in terms of quality of service.

In proposed algorithm i.e. improved DPCRA, the node categorization is done as DPCRA. Categorization allows identifying the partitioning and the non-partitioning nodes which is important for the recovery process. The information of partioning of the network enables to identify the criticality of node recovery at

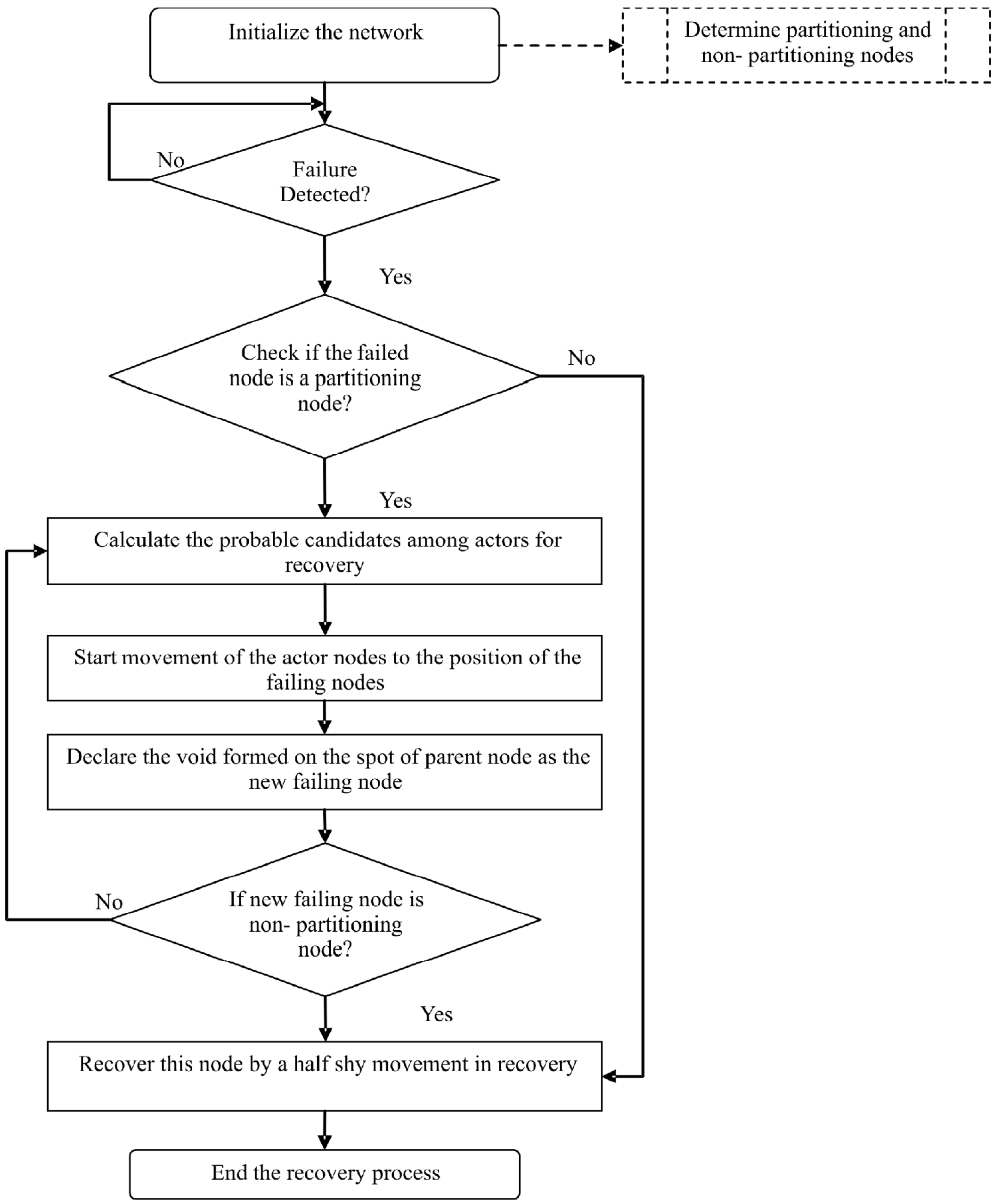

Figure 1: Flowchart of Proposed Algorithm

that particular point. The ability to identify the criticality of the failure enable to reduce the gap created by the recovery process because in case of non-partitioning node, the recover of the node does not take place completely according to the existing algorithms. In such case the approach used is to move for a distance which is less than the whole movement. In actual, the node recovery is done by reducing or sometimes eradicating the failure at the parent's initial spot by moving less than the actual recovery distance. Due to this movement, the parent node does not move too far from its original position helping in maintaining the connectivity of the network and saving the energy of the network which further leads to less failure probability of the network.

Figure 1 shows the flowchart of the proposed algorithm. Firstly, the network is initialized and the partitioning nodes and non – partitioning nodes are determined. Then, failure is detected. If the failure occurs, then check whether the failed node is partitioning node or not. If the failed node nde is partitioning node then recover it according to DPCRA otherwise recover it using the improved DPCRA.

V. SIMULATION

The goal of simulation is to show that the proposed approach performs better than the exisiting approach i.e. DPCRA. Improved DPCRA is simulated on MATLAB simulation environment. Table 1 shows the required simulation parameters used in the experimental simulations.

Table 1
Simulation Parameters

Network Parameters	*Value*
Simulation Area	500m x 500m
Nodes	10 – 100
Communication Range	10 – 100 m
Node Intial Energy	100J
Mobility Model	On demand mobility
Failure Model	Random

The actor nodes are randomly deployed in an area of 500m x 500m. The number of nodes deployed may vary from 10-100 with their transmission range 10 – 100 m. The results are calculated by simulating both existing and proposed algorithm i.e. DPCRA and Improved DPCRA respectively in the above mentioned environment.

VI. RESULTS AND DISCUSSIONS

The results of the simulation are based on three parameters i.e. energy consumed, distance moved and failure probability. For obtaining results of Improved DPCRA, first of all, network is deployed as shown in Figure 2 and then the nodes are categorized as shown in Figure 3. Nodes are categorized in two categories such as partitioning nodes represented by green color, these are the cut – vetrex nodes which leaves the system into disjoint sets and non partitioning nodes represented by blue and yellow color, nodes marked blue are non – leaf nodes but still are non – cut vertex nodes and nodes marked yellow are leaf nodes i.e. non – cut vertex nodes which does not partitioned the network.

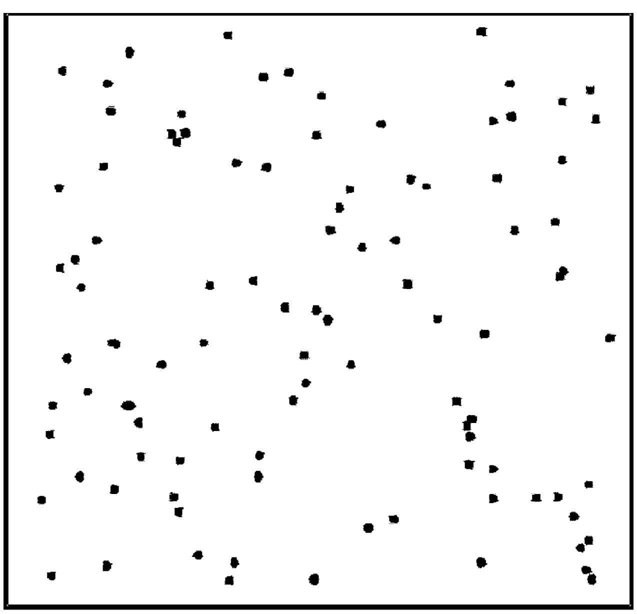

Figure 2: Deployed Network

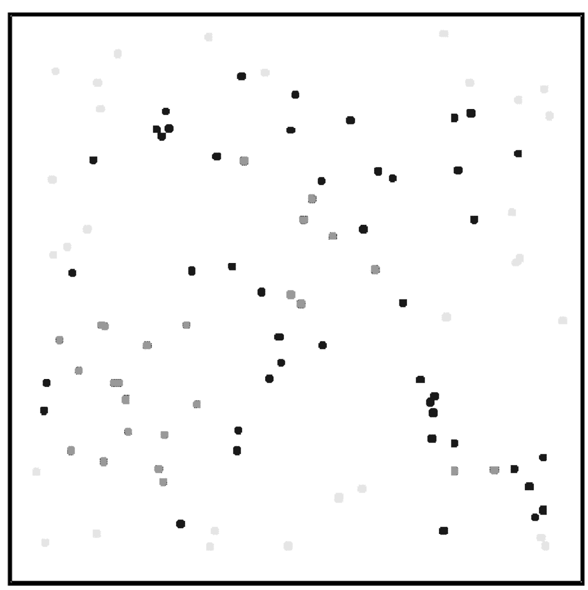

Figure 3: Categorized Nodes(Yellow nodes are leaf nodes i.e. non – cut vertex nodes, Blue nodes are non – leaf nodes but still non – cut vertex nodes and Green nodes are cut – vetrex nodes that partitiones the network if get failed.)

After the categoriztion of nodes, the failure is detected. The nodes which failed is represented by the red color node as shown in Figure 4. Then, the recovery process starts and the nodes included in the recovery process are represented by black color nodeas shown in Figure 5.

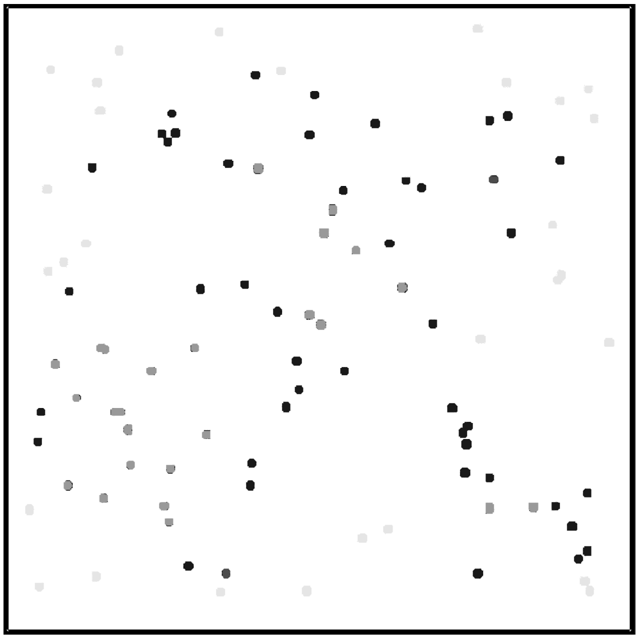

Figure 4: Nodes marked red are failure nodes

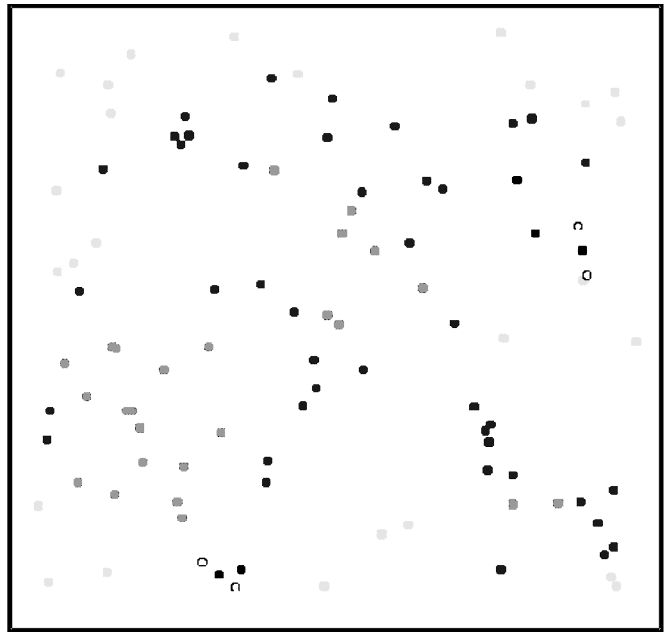

Figure 5: Nodes marked black are those nodes which are used in the recovery process

When the failure of the partitioning node happens it is recovered by the nearest actor node till the recovery reaches the non-partitioning node. When the failure of non- partioning node happens it is recovered by the nearest actor node by moving half a distance between the failed and recovery node as shown in Figure 5.

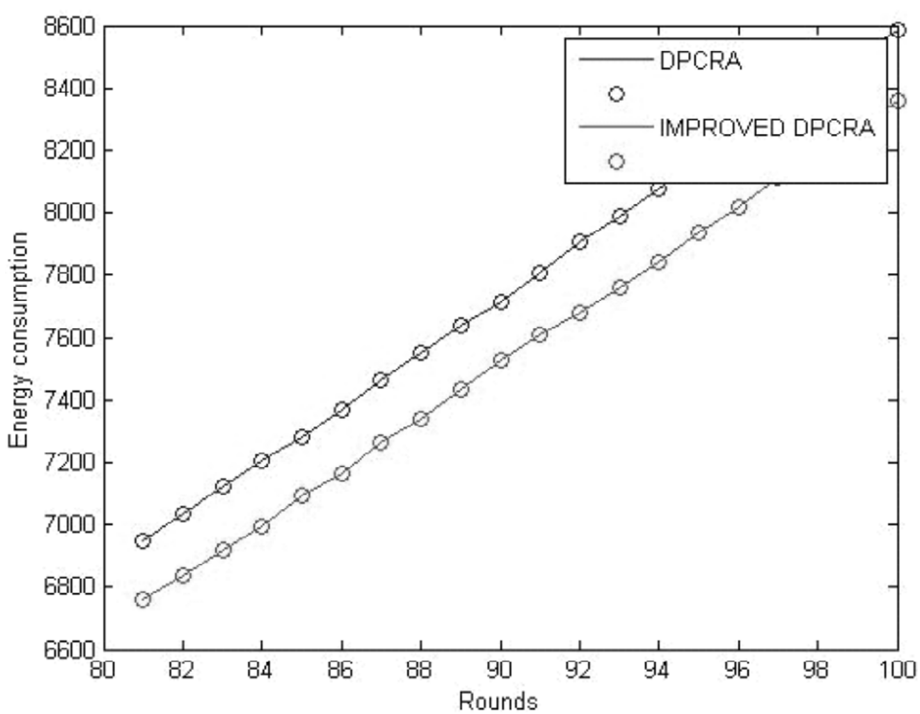

Figure 6: Energy Consumption

Figure 6 shows the plot of the Energy consumed per round versus rounds and it can evaluated through the graph that improved DPCRA consumes less energy than DPCRA.

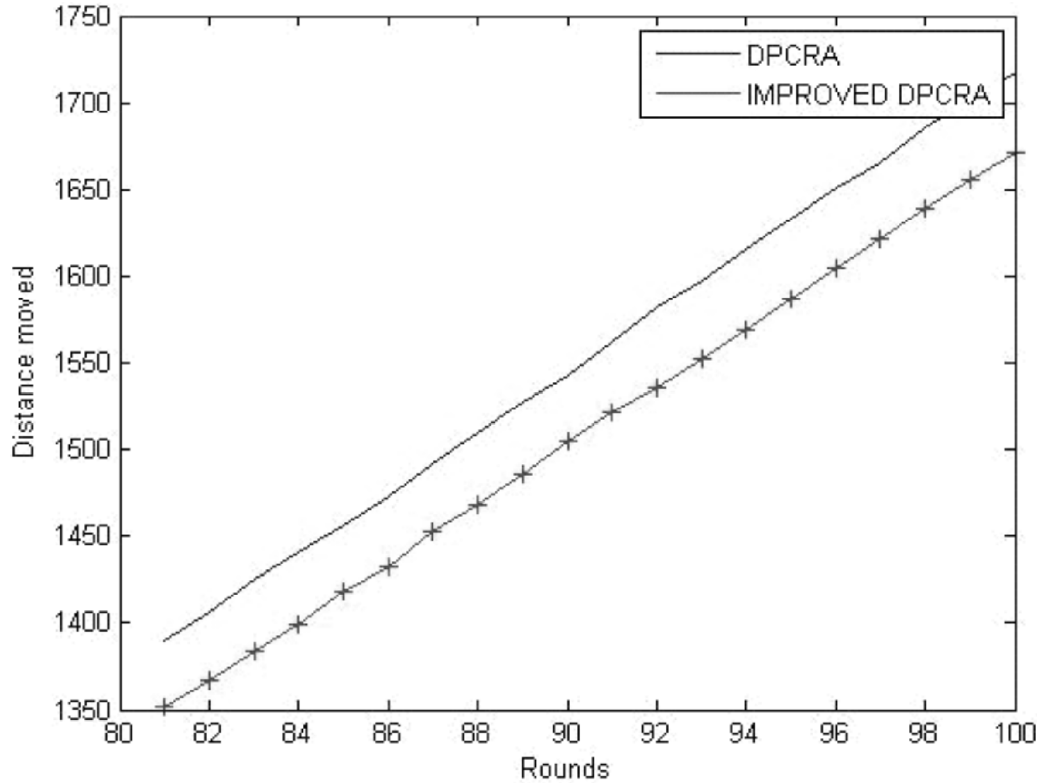

Figure 7: Average Distance Moved

Figure 7 shows the plot of the average distance moved per round versus rounds and average distance moved by the nodes in improved DPCRA is less than the existing algorithm.

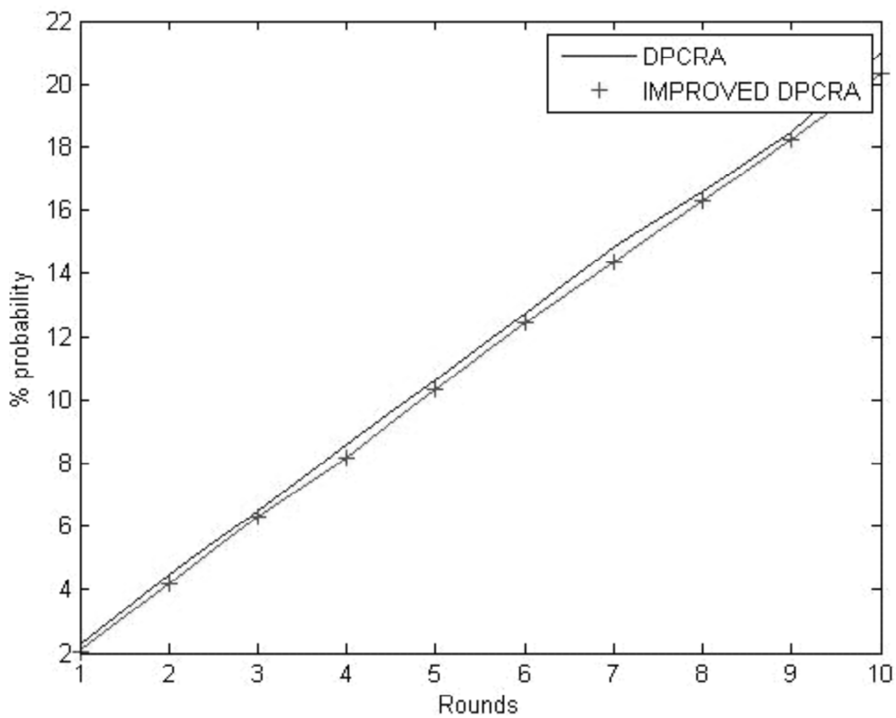

Figure 8: Failure Probability

Figure 8 shows the plot of the failure probability per round versus rounds. The failure probability gets reduced in improved DPCRA as it recovers the non- partioning nodes by moving half a distance only.

VII. CONCLUSION

In this paper, the node recovery technique DPCRA has been improved by inclusion of recovery of non-partitioning nodes. Both, DPCRA and Improved DPCRA have been implemented in the MATLAB simulation environment. The results of both the techniques have been analyzed on the basis of energy consumption over the hundred rounds of simulation, cumulative average distance moved and failure probability. In all three of the parameters used, the improved DPCRA performs better.

REFERENCES

[1] I. Akyildiz and I. Kasimoglu, "Wireless sensor and actor networks: research challenges", *Ad Hoc Networks*, vol. 2, no. 4, pp. 351-367, 2004.

[2] M. Younis and K. Akkaya, "Strategies and techniques for node placement in wireless sensor networks: A survey", *Ad Hoc Networks*, vol. 6, no. 4, pp. 621-655, 2008.

[3] A. A. Abbasi, K. Akkaya, and M. Younis, "A distributed Connectivity restoration algorithm in wireless sensor and actor networks," *32nd IEEE Conference on Local Computer Networks (LCN 2007)*, pp. 496–503, Oct. 2007.

[4] K. Akkaya, A. Thimmapuram, F. Senel, and S. Uludag, "Distributed recovery of actor failures in wireless sensor and actor networks," *2008 IEEE Wireless Communications and Networking Conference*, pp. 2480–2485, Mar. 2008.

[5] K. Akkaya, F. Senel, A. Thimmapuram and S. Uludag, "Distributed Recovery from Network Partitioning in Movable Sensor/Actor Networks via Controlled Mobility", *IEEE Transactions on Computers*, vol. 59, no. 2, pp. 258-271, 2010.

[6] M. Younis, S. Lee, S. Gupta, and K. Fisher, "A localized self-healing algorithm for networks of Moveable sensor nodes," *IEEE GLOBECOM 2008 - 2008 IEEE Global Telecommunications Conference*, pp. 1–5, 2008.

[7] A. Abbasi, M. Younis and U. Baroudi, "Restoring Connectivity in Wireless Sensor-Actor Networks with Minimal Topology Changes", *2010 IEEE International Conference on Communications*, pp. 1 - 5, 2010.

[8] A. A. Abbasi, M. Younis, and U. Baroudi, "Restoring connectivity in wireless sensor-actor networks with minimal node movement," *2011 7th International Wireless Communications and Mobile Computing Conference*, pp. 2046–2051, Jul. 2011.

[9] A. Alfadhly, U. Baroudi, and M. Younis, "Least distance movement recovery approach for large scale wireless sensor and actor networks," *2011 7th International Wireless Communications and Mobile Computing Conference*, pp. 2058–2063, Jul. 2011.

[10] V. Ranga, M. Dave and A. Verma, "A Hybrid Timer Based Single Node Failure Recovery Approach for WSANs", *Wireless Pers Commun*, vol. 77, no. 3, pp. 2155-2182, 2014.

[11] V. Ranga, M. Dave and A. Verma, "Network Partitioning Recovery Mechanisms in WSANs: a Survey", *Wireless Pers Commun*, vol. 72, no. 2, pp. 857-917, 2013.

[12] M. Younis, I. Senturk, K. Akkaya, S. Lee and F. Senel, "Topology management techniques for tolerating node failures in wireless sensor networks: A survey", *Computer Networks*, vol. 58, pp. 254-283, 2014.