Node Failure Recovery in Wireless Sensor and Actor Networks (WSAN) using ALeDiR Algorithm

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Abstract—Wireless sensor and actor networks (WSANs) refer to a group of sensors and actors linked by wireless medium to perform distributed sensing and actuation tasks. In such a network, sensors gather information about physical world, whereas actor takes decisions and perform appropriate actions upon the surroundings, that allows remote and machine-controlled interaction with the surroundings. Since Actors have to coordinate their motion in order to keep approachable to every node, a strongly connected network is needed all the time. However, a failure of an associated actor might cause the network to partition into disjoint blocks and would therefore violate such a connectivity requirement. In this project, a new algorithmic rule is proposed. which is localized and distributed algorithm that leverages existing route discovery activities within the network and imposes no extra pre-failure communication overhead.

Keywords— wireless sensor and actor networks(WSAN), Multiple node failure, Disjoint Blocks, Overhead Management, pre failure, network recovery, Actor Movement.

INTRODUCTION

In recent years wireless sensor and actor networks gaining growing interest due to their suitableness for the applications in remote and harsh areas where human intervention is risky. Samples of these applications includes disaster management, search and rescue, fire observance, field intelligence operation, space exploration, coast and border protection, etc. WSANs comprised of varied miniaturized stationary sensors and fewer mobile actors. The sensors acts as data acquisition devices for the powerful actor nodes that analyses the sensor readings and gives an appropriate response to achieve predefined application mission.

For example, sensors could detect a high temperature and trigger a response from an actor that will activate air conditioner. Robots and pilotless vehicles are example actors in observe. Actors work autonomously and collaboratively to attain the appliance mission. For the cooperative actors operation, a powerfully connected inter-actor configuration would be needed at all times. Failure of one or more nodes could partition the inter-actor network into disjoint blocks. Consequently, associate inter-actor interaction will fail and the network would not be able to deliver a timely response to a significant event. Therefore, recovery from associate actor failure have the most importance in this scenario.

The remote setup during which WSANs usually serve makes the readying of extra resources to switch failing actors impractical, and emplacement of nodes becomes the simplest recovery possibility. Distributed recovery are going to be difficult since nodes in separate partitions will not be ready to reach one another to coordinate the recovery method. Therefore, each node has to take care of partial data of the network state. To avoid the excessive state-update overhead and to expedite the property restoration method, previous work depends on maintaining one-hop or two-hop neighbour lists and predetermines some criteria for the node's involvement within the recovery.

In contrast to previous work, this paper considers the property of restoration that subject to path length constraints. In some applications, timely coordination among the actors is needed, and also lengthening the shortest path between two actors also would not be acceptable.

Most of the existing approaches within the literature are strictly reactive with the recovery method initiated once the failure “F” is detected. the most plan is to replace the unsuccessful node “F” with one in every of its neighbours or move those neighbours inward to autonomously mend cut topology within the neighbourhood of F.

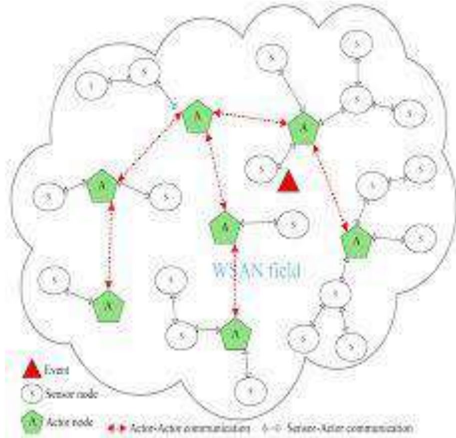

Fig:1 An Example wireless sensor and actor network setup

SYSTEM MODEL AND PROBLEM STATEMENT

There are two types of nodes in WSANs: 1)sensors and 2)actors. actors are have more onboard energy when compared to sensors and they are richer in computation and communication resources. Whereas sensors are highly constrained in energy and are inexpensive. The transmission range of actors is finite. In this paper actor and node will be used interchangeably.

Based on the impact of the actor's failure in the network, the nodes are classified into 2 types. The leaf node and critical node. The leaf node is the one, on removal of the node there will be not much effect on the network. They are also regarded as children nodes. Whereas the critical node is the one, on failure of that node the network will become into disjoint blocks. This critical node is also called as cut vertex. For restoring network connectivity in partitioned off WSANs variety of schemes have recently been proposed. All of those recovery methodologies have targeted on reestablishing cut links while not considering the impact on the length of pre-failure knowledge ways. Some schemes recover the network by repositioning the existing nodes, whereas others fastidiously place additional relay nodes. On the opposite hand, some work on device relocation focuses on metrics aside from property, e.g., coverage, network longevity, and quality safety, or to self-spread the nodes once non-uniform readying.

Existing recovery schemes either impose high node relocation overhead or extend a number of the inter-actor communication path.

RELATED WORK

A number of schemes have recently been planned for restoring network connectivity in WSANs [1]. All of those schemes have concentrated on reestablishing cut off links while not considering the impact on the length of pre-failure information methods. Some schemes recover the network by placement the prevailing nodes, whereas others rigorously place extra relay nodes. Like our planned DCR algorithmic program, DARA [6] strives to revive property lost as a result of failure of cut-vertex. However, DARA needs additional network state in order to make sure convergence. Meanwhile, in PADRA [8], it determines a connected dominating set (CDS) of the full network so as to discover cut-vertices. Although, they use a distributed algorithmic program, their resolution still needs 2-hop neighbour's data that will increase electronic communication overhead.

Another work planned in [6] uses 2-hop data to discover cut-vertices. The planned DCR algorithmic program depends solely on 1-hop data and reduces the communication overhead. Though RIM [13], C3R [7] and tape machine [15] use 1- hop neighbour data to revive connectivity, they are strictly reactive and don't differentiate between critical and non-critical/children nodes. Whereas, DCR could be a hybrid algorithmic program that proactively identifies crucial nodes and designates for them applicable backups. the existing work on synchronic node failure recovery planned in [10] could be a mutual exclusion mechanism known as [14] so as to handle multiple synchronic failures in a very localized manner.

The approach in this paper differs from MPADRA in multiple aspects. Whereas, it solely needs 1-hop data and every critical node has just one backup to handle its failure.

PROPOSED SYSTEM

In this project, a new approach for the network recovery is proposed based on extra actor(Aggrandized Least Disruptive topology Repair). Here the extra actor node will acts as a centralized node, which will control the node movements. This methodology's main task is to overcome the multi-node failures. The performance of ALeDiR is simulated on NS2 tool.

IMPLEMENTATION

1. Failure Detection

Actors continuously send heartbeat messages to their neighbors to make sure that they are functional and conjointly report changes to the one-hop neighbors. Missing heartbeat messages will be used to observe the failure of actors.

After that it simply checks whether the failed node is critical node or not. If it is children node there will be not much effect on the network. If it is Critical node, disjoint blocks will result within the network.

2. Smallest block identification

In this step the smallest disjoint block has to be taken. If it is small then it will scale back the recovery overhead within the network.

- The smallest block is that the one with the smallest amount of nodes
- By finding the accessible set of nodes for each direct neighbor of the failing node then selecting the set with the fewest nodes.

3. Substitution of faulty node and children movement

Here in this step, the faulty node is to be substituted by extra actor and to restore the network quickly. When the node failure is detected by heart beat message then extra actor node will move to that particular location and it will take care of the restoration, i.e., it will control the actor movements. It will find which nodes are affected by the failure and inform to that nodes to which position they have to move. After restoration the extra actor will go back to its original position.

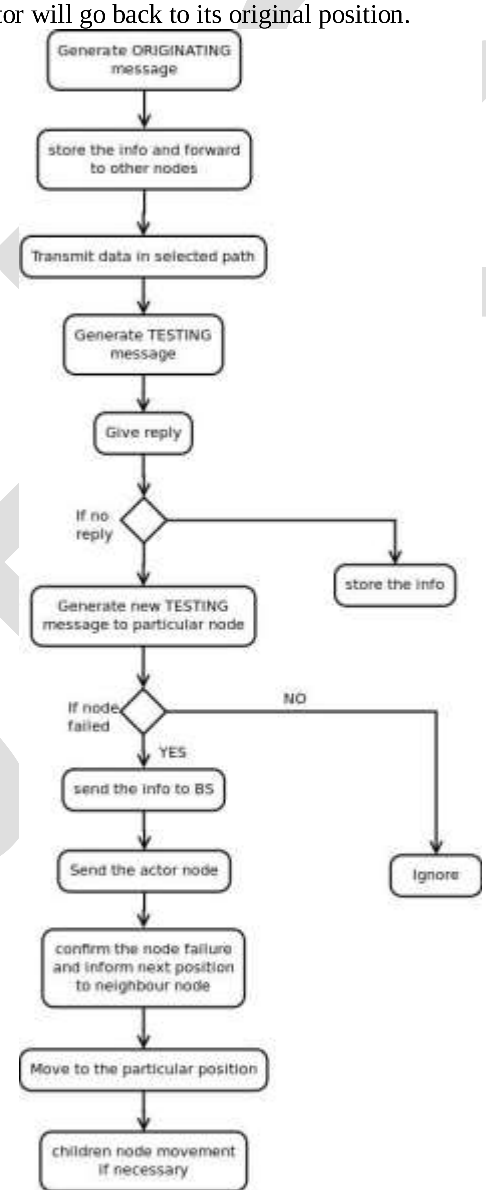

Fig: 2 Implementation Flow Chart

RESULTS

Here the system performance analysis is done based on number of nodes involved in restoration, PDF(packet delivery fraction),end to end delay and Overhead which are explained below.

The Fig.(3) shows the comparison of end to end delay in the network of the existing and proposed method. The X-axis represents the protocol and Y-axis represents the delay in seconds. In the existing LeDiR method we have 1.5s delay where as in proposed ALeDiR method we have only 0.2s delay.

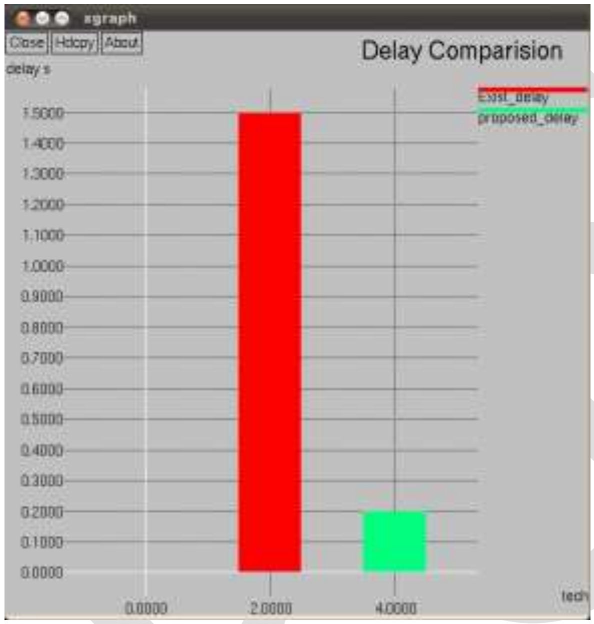

Fig: 3DelayComparison between LeDiR&ALeDiR

The Fig.(4) represents number of nodes involved in the restoration of the network. Here X-axis represents protocol and Y-axis represents number of nodes. Here we can clearly observe that in LeDiR six nodes involved in restoration which will creates more disturbances in the network but in ALeDiR only three nodes involved in the restoration.

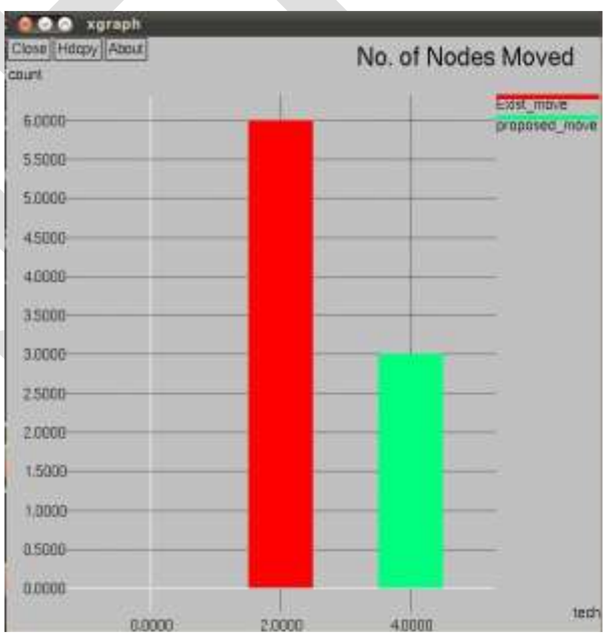

Fig: 4 No. of nodes moved in LeDiR&ALeDiR

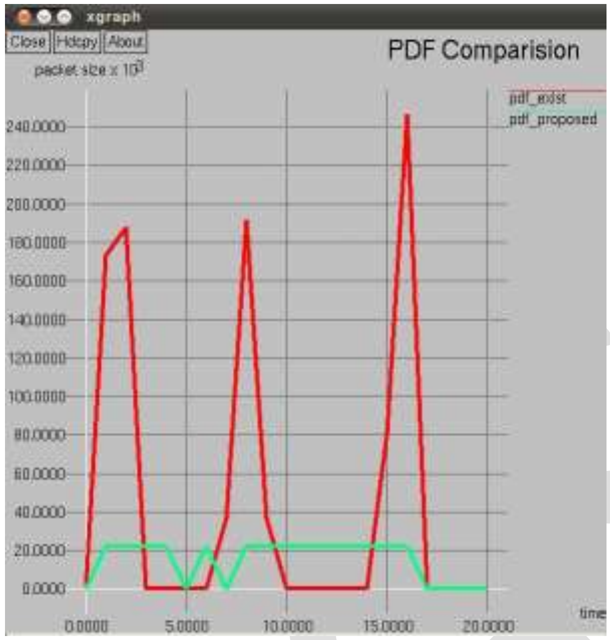

Fig: 5 PDF Comparison between LeDiR&ALeDiR

The Fig.(5) represents packet delivery fraction of the network. In thisX-axis represents protocol and Y-axis represents percentage of packets delivered. In multi node failure case LeDiR shown non-uniform packet delivery but in the proposed ALeDiR method it shows maximum uniform packet delivery.

The Fig.(6) represents the Overhead of the network in LeDiR and ALeDiR. In this X-axis represents protocol and Y-axis represents the number of overhead packets size. Compared to LeDiR the ALeDiR contains less Overhead.

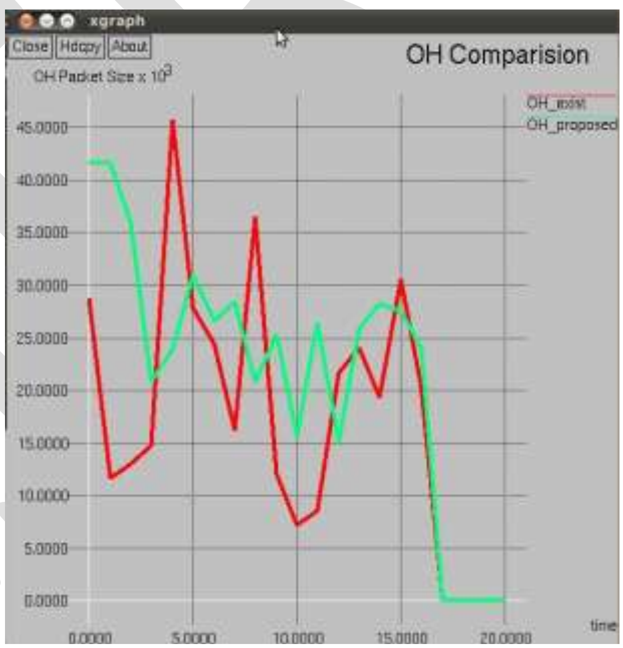

Fig :6 OH Comparison between LeDiR&ALeDiR

CONCLUSION

Inter-actor network connectivity is essential in most of the WSAN applications to perform collaborative actions in an efficient manner. Therefore, maintaining strong inter-actor connectivity throughout the network operation is crucial. This paper, presents a local, distributed and movement efficient protocol which can handle the failure of any node in a connected WSAN. Simulation results confirmed that the new approach performed very close to the optimal solution in terms of delay, PDF, overhead, nodes involved while keeping the approach local and thus minimizing the message complexity. In addition, this approach outperformed LeDiR in terms of travel distance which requires the knowledge of 2-hops for each node.

In the future, the travel distance performance can be improved by adapting a distributed dynamic programming approach when determining the closest dominatee.

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