Fault Tolerance Mechanism using Clustering for Power Saving in Wireless Sensor Networks

Navmeet Kaur[1], Kamaljit Kaur[2]
[1]Research Fellow, [2]Asst. Professor
[1,2]Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab.

Abstract — The dependability of wireless device networks (WSN) is laid low with faults which will occur attributable to varied reasons like malfunctioning hardware, software system glitches, dislocation, or environmental hazards, e.g. fire or flood. A WSN that's not ready to take care of such things may suffer a discount in overall lifespan, or lead to hazardous consequences in important application contexts. In our proposed work we will propose the fault tolerance mechanism by finding the fail over scenario and will select the backup cluster head. In case of failure of primary cluster head, back up cluster head will take place of primary cluster head automatically. The results shows that the performance of the proposed scheme for finding better fault tolerance in wireless sensor network. Traditional SECA scheme provide good solution for finding cluster heads with good approach but proposed scheme have much better performance in finding cluster heads. The accuracy of the finding cluster heads much improved than the SECA method for energy saving in wireless sensor network. The purpose of back up cluster heads is very helpful in saving energy.

***Keywords*— Fault tolerance, Energy Efficiency, Lifetime, Wireless Sensor Network.**

I. INTRODUCTION

Wireless device network (WSN) is wide thought-about in concert of the foremost necessary technologies for the ordinal century [3]. Within the past decades, it's received tremendous attention from each domain and trade everywhere the globe. A WSN generally consists of an outsized variety of cheap, low-power, and multifunctional wireless device nodes, with sensing, wireless communications and computation capabilities [2, 3]. These device nodes communicate over short distance via a wireless medium and collaborate to accomplish a typical task, as an example, atmosphere observation, military police work, and process management [4]. The fundamental philosophy behind WSNs is that, whereas the aptitude of every individual device node is proscribed, the combination power of the complete network is ample for the desired mission. In several WSN applications, the readying of device nodes is performed in a poster hoc fashion while not careful coming up with and engineering. Once deployed, the device nodes should be able to autonomously organize themselves into a wireless communication network. Device nodes square measure powered and square measure expected to work while not attending for a comparatively long amount of your time. In most cases it's terribly troublesome and even not possible to alter or recharge batteries for the device nodes. WSNs square measure characterised with denser levels of device node readying, higher undependableness of device nodes, and severs power, computation, and memory constraints. Thus, the distinctive characteristics and constraints gift several new challenges for the event and application of WSNs. attributable to the severe energy constraints of huge variety of densely deployed device nodes, it needs a set of network protocols to implement numerous network management and management functions like synchronization, node localization, and network security. the normal routing protocols have many shortcomings once applied to WSNs, that square measure chiefly attributable to the energy-constrained nature of such networks [4]. As an example, flooding may be a technique within which a given node broadcasts information and management packets that it's received to the remainder of the nodes within the network. This method repeats till the destination node is reached. Note that this system doesn't take under consideration the energy constraint obligatory by WSNs. As a result, once used for information routing in WSNs, it ends up in the issues like implosion and overlap [5, 6]. Only if flooding may be a blind technique, duplicated packets could keep flow into within the network, and thence sensors can receive those duplicated packets, inflicting associate implosion drawback. Also, once 2 sensors sense constant region and broadcast their detected information at constant time, their neighbours can receive duplicated packets. to beat the shortcomings of flooding, another technique referred to as gossip mongering will be applied [10]. In gossip mongering, upon receiving a packet, a device would choose willy-nilly one in all its neighbours and send the packet thereto. Constant method repeats till all sensors receive this packet. Mistreatment gossip mongering, a given device would receive just one copy of a packet being sent. Whereas gossip mongering tackles the implosion drawback, there's a major delay for a packet to succeed in all sensors in an exceedingly network. What is more, these inconveniences square measure highlighted once the quantity of nodes within the network will increase.

Saving energy clustering algorithm (SECA)

In order to increase energy efficiency and extend the lifetime of the sensor nodes in wireless sensor networks, efficient power saving algorithm must be

developed and designed. Based on the centralized clustering architecture, a new algorithm SECA is used to provide efficient energy consumption and better network lifetime in the wireless sensor networks. In this scheme, assume that the BS receives the information of location and residual energy for each sensor node and the average residual energy can be calculated. When the residual energy of sensor node is higher than the average residual energy, the sensor node becomes a candidate of cluster head. Modify k-means algorithm to make an ideal distribution for sensor node clusters by using the information of location and residual energy for all sensor nodes [12, 13]. In this algorithm, the operation includes two phases: set-up and steady-state phases. The main goal of this phase is to create clusters and find cluster head nodes. During the set-up phase, the BS collects the information of the position and energy level from all sensor nodes in the networks. Based on the characteristics of stationary sensor nodes, the suitable initial means of points for clusters can be obtained.

II. REVIEW OF RELATED WORK

Jau-Yang Chang and Pei-Hao Ju in 2012 [1] In this article, efficient power saving scheme and corresponding algorithm must be developed and designed in order to provide reasonable energy consumption and to improve the network lifetime for wireless sensor network systems. The cluster-based technique is one of the approaches to reduce energy consumption in wireless sensor networks. In this article, we propose a saving energy clustering algorithm to provide efficient energy consumption in such networks. The main idea of this article is to reduce data transmission distance of sensor nodes in wireless sensor networks by using the uniform cluster concepts. In order to make an ideal distribution for sensor node clusters, we calculate the average distance between the sensor nodes and take into account the residual energy for selecting the appropriate cluster head nodes. The lifetime of wireless sensor networks is extended by using the uniform cluster location and balancing the network loading among the clusters. Simulation results indicate the superior performance of our proposed algorithm to strike the appropriate performance in the energy consumption and network lifetime for the wireless sensor networks.

K Abbas Nayebi, Hamid Sarbazi-Azad in 2011 [2] elaborated that In many wireless sensor network applications, nodes are mobile, while many protocols proposed for these networks assume a static network. Thus, it is important to evaluate if a traditional protocol designed for a static network can tolerate different levels of mobility. This paper provides an analytic model to investigate the effect of mobility on a well-known cluster-based protocol, LEACH. The model evaluates data loss after construction of the clusters due to node mobility, which can be used to estimate a proper update interval to balance the energy and data loss ratio. Thus, the results can help the network designer to adjust the topology update interval given a value of acceptable data loss threshold. A practical approach to increase the mobility tolerance of the protocol is applying a buffer zone to the transmission ranges of the nodes. The model is extended in order to consider the effect of buffer zone. To validate the analytic evaluations, extensive simulations are conducted and correctness of the evaluations is tightly verified.

Srinivasan in 2006, [12] in their study described that wireless sensor networks (WSNs) are shaping many activities in our society, as they have become the epitome of pervasive technology. WSNs have an endless array of potential applications in both military and civilian applications, including robotic land-mine detection, battlefield surveillance, target tracking, environmental monitoring, wildfire detection, and traffic regulation, to name just a few. One common feature shared by all of these critical applications is the vitality of sensor location.

Cherif Diallo in 2010 [13] have proposed a new protocol Link Quality Indicator based clustering protocol (LQI-DCP). In WSN, it is not often desirable to use the GPS-technology. Because the use of GPS is expensive and may reduce the overall network performance. Moreover, indoor reception of GPS signal is not possible. LQI-DCP is a distributed clustering protocol which aims to construct d-hops clusters, that is to say d-dominant subsets of WSN where each node within a cluster is at most at d-wireless hops away from its cluster head. The authors have compared it with optimized form of the Max-Min protocol in MATLAB, and proposed that LQI-DCP decreases the density of cluster heads, gives better location of carryommes which are sufficiently outspread, and then increases the overall energy efficiency of the network.

Yongchang, in 2010 [14] have proposed EECB (Energy Efficient Chain Based routing protocol) that is an improvement over PEGASIS. Different from PEGASIS whose leader node in each round of communication is at a random position of the chain. EECB uses distances between nodes and the Base Station (BS) and remaining energy levels of the nodes to decide which node qualified to be the leader, of the chain. EECB adopts distance threshold to avoid formation of long link (LL) on the chain. EECB will choose a new leader according to Q after each round ends.

$$Qi = Eresidual\text{-}i / di$$

Eresidual-I is the residual energy of node I at the current round. The node with maximal Qi becomes the leader.

Jun Chang, in 2010 [15] have described a model of coverage issues based on the Voronoi diagram and Delaunay triangulations and designed the coverage control algorithm. Authors proposed algorithm to consider how to sense and track the target across which travel the network. In the case of worst coverage, authers went to find a path that the probability of targets being detected when traversing the WSN is minimum,namely,the “Maximal Breach Path”, making the minimal distance from nodes in path to the closes sensors maximized. In the case of the

based coverage , authors went to find a path that the probability of targets being detected when traversing the WSN is maximum, namely, the "Maximal Support Path", making the maximal distances from nodes in path to the closest sensors minimized.

Elham Hajiam, in 2010 [16] have proposed a new method for selection of data transmission route based on Learning Automata that selects the route with regard to energy parameters and the distance to sink. The proposed algorithm selects the best modes from among all modes using learning automata that has trainable deciding structure and after selecting the best mode and its effect on the environment and feed-back from the environment, each movement it selects the best route. The basis of this process is that each node has learning automata. Authors have also cited future works for improving this algorithm in delay parameters as well as utilizing it in other routing protocols.

Ching lijun, in 2010 [17] have established a fault diagnosis system through writing wave let de-noising and fault diagnosis program in the DSP processor. It improves the SNR. Through the soft and hard ware design, the sensor self check and self adjust function was achieved. Compared with traditional condition monitoring system, this system not only has small cubage but also has higher reliability and intelligent.

Shih-Hao Chang in 2010 [18] have described a fault tolerance model for WSN based on Casual Model Method (CMM). It is an explicit fault tolerance mechanism that is suitable for WSN. It uses reputation checker, ontology manager and action planner schemes to provide efficient fault tolerance algorithm in WSN. The new method consists of the phases to define the node failure source as collect, classify, and correct. Simulation results show that CMM can improve WSN performance and reliability.

III. PROPOSED FAULT TOLERANCE MECHANISM

Fault tolerance Mechanism for efficient cluster based power saving scheme for WSN. The algorithm assumed that the base station receives the information of location and residual energy for each sensor node and the average residual energy can be calculated. When the residual energy of sensor node is higher than the average residual energy, the sensor node becomes a candidate of cluster head.

In our proposed work i.e FSeca we will propose the fault tolerance mechanism by finding the fail over scenario and will select the backup cluster head. In case of failure of primary cluster head, back up cluster head will take place of primary cluster head automatically.

3.1 Proposed Model

The fault tolerance process is one of the best problems to solve in wireless sensor network. Matlab is used for experimentation with area of 100 × 100 meters with 100 numbers of sensors. The objectives of proposed work are:

- To improve the energy efficiency
- Implementation of good fault tolerance mechanism in wireless sensor networks.

3.2 Proposed Methodology

The research on providing better fault tolerance is start with information fetching about the protocols of the wireless sensor network with power aware protocols as a prime areas.

We started with understanding different power efficient data gathering protocols of wireless sensor network and started with leach enhancement process for providing fault tolerance by introducing clustering approach for selecting cluster head. We implement already introduced protocol known as saving energy clustering algorithm (SECA) to provide efficient energy consumption in wireless sensor networks. In order to make an ideal distribution for sensor node clusters, we calculate the average distance between the sensor nodes and take into account the residual energy for selecting the appropriate cluster head nodes. The lifetime of wireless sensor networks is extended by using the uniform cluster location and balancing the network loading among the clusters. The main benefits of proposed scheme are that the energy consumption is reduced and better network lifetime can be carried out. We then find the center and data points described in related study in uniform way. Cluster head has been selected as primary and secondary according to the uniform way based on distance concept. Secondary cluster head has been selected as successor for the cluster head and in case of failure of primary cluster head, secondary will take place as cluster head.

The Base station collects the information of the position and energy level from all sensor nodes in the networks. Based on the characteristics of stationary sensor nodes, the suitable initial means of points for clusters can be obtained. Finally comparison of the schemes has been considered.

IV. RESULTS

A proposed clustering approach is used to implement the desired solution for fault tolerance. The simulation area is considered as 100 × 100 meters with 100 sensor nodes has been considered. Fig 1 shows the number of dead nodes with time. In case of SECA, the numbers of dead nodes are more as compared to the proposed work i.e. Fseca because in proposed work, we have save a lot of resources by using innovative clustering approach.

Amount of data transferred from different sensor nodes to sink is shown in the Fig 2, which is much better in case of FSeca to the clustering approach. Fig 3 shown below explains that the energy consumption is less in case of FSeca than the SECA method.

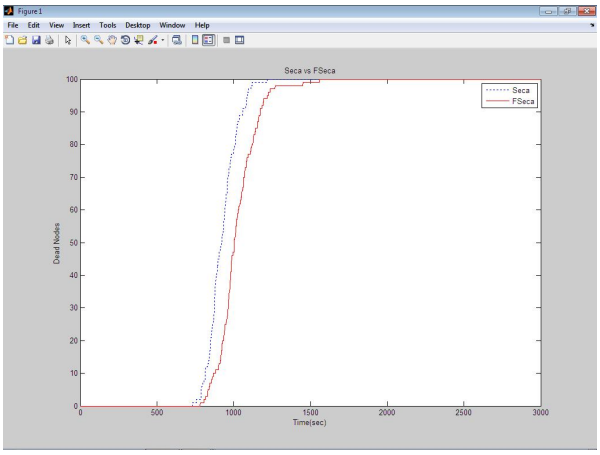

Fig 1: Number of dead nodes with accordance to time

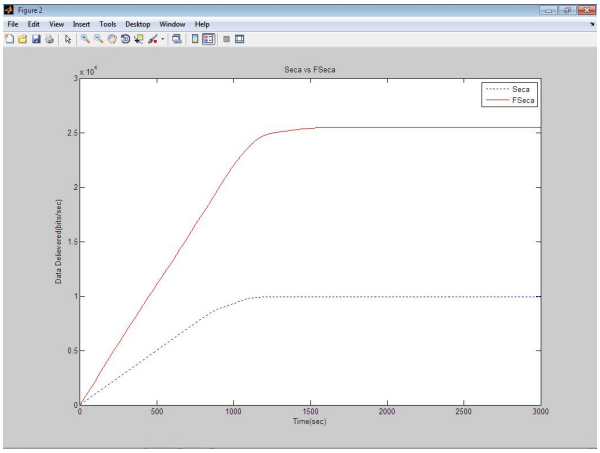

Fig 2: Data transferred of SECA and FSeca

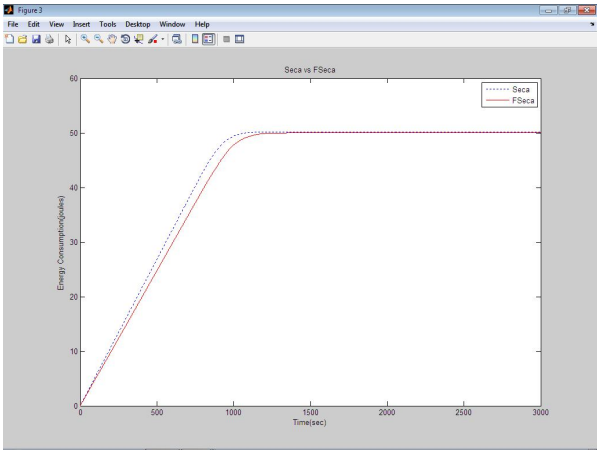

Fig 3: Energy Consumption of SECA and FSeca

The results shown above summarized the performance of the proposed scheme i.e Fseca for finding better fault tolerance in wireless sensor network. Traditional SECA scheme provide good solution for finding cluster heads with good approach but proposed scheme have much better performance in finding cluster heads. The accuracy of the finding cluster heads much improved than the SECA method for energy saving in wireless sensor network. The purpose of back up cluster heads is very helpful in saving energy.

V. CONCLUSION

Our Proposed work i.e FSeca is based on the saving energy consumption in the wireless sensor network. Fault tolerance concept is important sate to achieve in the sensor communication. This research is very useful in finding cluster head accurately and providing node failure by electing various back up cluster heads so that in case of failure, backup cluster heads can take place of primary cluster heads. This proposed approach has considered clustering and RSSI value of the sensors for finding the cluster heads and backup cluster head nodes.

Moreover getting a backup clustering approach could also helpful in saving a lot of energy individually in the sensors in the network. Propagation models are useful in finding motion of the sensor nodes and can be locked using anchor nodes along with RSSI value. Comparison has shown the improvement in data transferred, accuracy in cluster finding, balance, distribution of data and number of dead nodes in wireless sensor network. Our proposed work has shown better values in all parameters as compared to SECA protocol scheme.

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