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Performance Evaluation of Wireless Sensor Network using Genetic Algorithm

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Abstract—*This article presents evolutionary computation approach i.e. genetic algorithm for improving performance of wireless sensor network in disaster conditions. An successful disaster management requires fast synchronization of existing resources. At time of disaster, wireless sensor network becomes very complex. In such conditions Connectivity among nodes should be maintained. in disaster scenarios due to constrained and mobile conditions it becomes difficult to maintain connectivity. In this paper we propose Genetic Algorithm for performance enhancement of wireless sensor network in disaster condition since number of parameters are considered, a genetic algorithm and the network simulator NS-2 is proposed for simulation..*

***Key Words**: wireless sensor network , disaster management Genetic Algorithm, MANET, Connectivity, NS-2.*

1. Introduction

Natural disasters usually results in loss of life as well as severe damage to property and the surrounding environment. Therefore, it is important to perform effective emergency plans to tackle these natural disasters. Natural disaster may occur anytime, therefore precautionary steps are essential. A natural disaster scenario is not only dynamic but also highly complicated in terms of resources. When disaster occurs probability of destruction of Communications systems is very high. Most of nodes stop working and may create blockage in maintain connectivity. MANET is group of mobile nodes that form network. There is no need of underlying infrastructure. In disaster scenario connectivity as quality of service should be guaranteed in order to achieve required level of disaster management. In this article we propose evolutionary based approach called Genetic Algorithm to improve performance of wireless sensor network in disaster scenario. The challenges faced by network in disaster are in network each node has different feature in terms of mobility. On the other hand, the power transmission is a design factor; it depends on the technology used. Other problem faced are Communications in disaster scenarios are carried out during very short periods of time and normally such communications are broadcasting packets shared by nodes in order to inform and alert other nodes about the situation therefore fast coordination is highly expected. These messages are normally forwarded from a source node to a destination node. Collisions and congestion are the classical problems, and they become more severe in disaster thus deteriorate the performance of the wireless sensor network.

Connectivity maintenance in disaster conditions can also be observed as topology problem [6]. In Topology problems objective is to find optimal topology to optimize several parameters. The use of NS-2 to evaluate the fitness function is very interesting. It allows the designer to model the communication layers and the signal propagation models in disaster . Xu et al. [6] included a GA in NS-2 for analyzing topology control in ad hoc wireless networks. To summarize, this article deals with increasing performance of wireless sensor network for disaster management. The main objective is to demonstrate whether evolutionary computation techniques can enhance performance of wireless sensor network for disaster management. The network simulator NS-2 [1] is useful to model the communication layers of ad hoc network. Section 2 contains the proposed approach to solve the connectivity problem, and Section 3 describes the implementation of the genetic algorithm. Finally simulation results and conclusions are presented in Section4 and 5 respectively.

2. PROPOSED APPROACH

Wireless sensor network parameters in disaster are evaluated using a genetic algorithm. Genetic algorithm combined with the network simulator NS-2 is proposed for disaster management. The performance parameters considered for evaluation are throughput, packet delivery ratio and energy consumption. Genetic algorithms are set evolutionary algorithm. They use techniques, which inspired from evolutionary biology such as inheritance, selection, crossover and mutation.NS-2 is object oriented simulator. It is widely used by research and academics in order to simulate both wired and wireless networks. NS-2 is used to evaluate fitness function. TCL is programming used. Results can be verified with help of c program to check weather desired optimal outcome has been achieved or not. If desired optimal outcome is not achieved then new generation are again created with help of genetic operations such as crossover and mutation as shown in fig1.[1] generation are again created with help of genetic operations such as crossover and mutation as shown in fig1.[1]

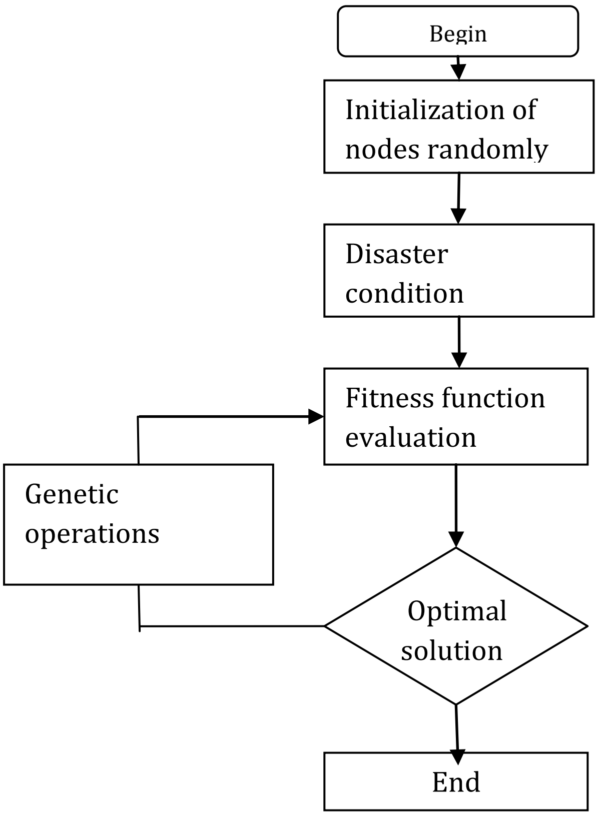

Fig1. flow chart of GA

3. GENETIC ALGORITHM IMPLEMENTATION

Genetic algorithm belongs to class of evolutionary algorithm. These algorithms are based on the principles of evolutionary biology. Genetic algorithm is implemented using computer simulations. These algorithms have potential to provide solution to specific problem. In genetic algorithm population of chromosomes are transformed in to optimized problem. Usually solutions are encoded in binary form but other codes are also permitted. The evolution begins with population of randomly generated individual. In each generation fitness value is evaluated and based on this fitness value multiple individual are selected from current population and modified to form new population. This new population is formed with help of mutation and crossover. The algorithm starts using initial populationT_i. Initial population is composed of M_t chromosomes. This initial population is randomly generated. Crossover and mutations are responsible for generation of new population. In crossover process two members of a population T_j are utilized as input and two new members of the next population T_{j+1} are generated. Thus genetic information from the predecessors is included in new chromosomes. Genetic information of a chromosome included in T_j is changed to generate a new chromosome of $T_{j+1}$with help of mutation process. Fig. 1 illustrates proposed genetic algorithm.

3.1. Encoding of chromosomes

A chromosome is a set of positions of the sink nodes and it is denoted as S_i. The nodes are deployed widely and they form a collaborative network working along with the mobile nodes. We denote J (T_1 , T_2, T_3 …….T_n) as the set of parameters coded to form the chromosome, where n is the total number of parameters. We denote number of bits as BI_l . Each parameter is coded using a number of bits BI_l (from $l = 0\ to\ l = n$). The chromosome's length LEN is defined as follows :

$$LEN = \sum_{l=0}^{n} BI_l \qquad (1)$$

3.2. Fitness function evaluation

Fitness function evaluates goodness of chromosomes. We evaluate Fitness function with help of simulation NS2. The fitness function interprets the chromosome in terms of physical representation and evaluates its fitness based on behavior of being most wanted in the solution. But Fitness function must accurately measure quality of chromosomes. Therefore, the fitness function that involves computational efficiency and accuracy of parameters is defined as follows [3].

$$ff_i = \frac{1}{\sum_{j=1}^{l_i-1} C_{g_{i(j)},\, g_{i(j+1)}}} \quad (2)$$

Where ff_i represents the fitness value of the chromosome, l_i is the length of the chromosome, $g_{i(j)}$ represents the gene (node) of the locus in the j chromosome, C is the link cost between nodes. The fitness function of GAs can also be stated as the objective function that requires to be optimized. the fitness function can be thought of as fully representing the objective of function. The fitness function has a higher value when the fitness characteristic of the chromosome is better when compared with other functions. Moreover fitness function also introduces a criterion for Selection of chromosomes.

3.3. Selection procedure

The purpose of selection process is to improve quality of population. Chances of high quality chromosomes to be selected in next generation are increased through this process. The selection thereby focuses the searching on capable regions in the solution space. Selection pressure is defined as the ratio of the probability of selection of the best chromosome in the population to that of an average chromosome. Hence, a high selection pressure results in the population's reaching equilibrium very quickly. [1]There are two basic types of selection scheme used commonly in current practice: proportionate and ordinal-based selection. In Proportionate selection , chromosomes based on their fitness values relative to the fitness of the other chromosomes in the population are picked . It is generally more susceptible to selection pressure. For redistributing the fitness range of the population in order to adapt to the selection pressure a scaling function is employed. In Ordinal-based selection schemes chromosomes are selected based upon their rank within the population not upon their fitness. Each chromosome is ranked according to their fitness values. Selection pressure is independent of the fitness distribution of the population, and is based exclusively on the relative ranking of the population. Selection pressure is the degree to which the better chromosomes are favored. Thus with the help of selection process, population fitness of genetic algorithm is enhanced.

3.4. Transition

The procedure used to generate a new population T_{j+1} from the previous population T_j is called as transition. In transition process first best chromosomes are copied from T_j to T_{j+1} . Thus probability that the best individuals of each population will be included in the next generation is increased. Thus utilization probability of good chromosomes in reproduction is increased .The new chromosomes are generated by using crossover and mutation operations. This also support in maintain diversity of the chromosomes. The probability of a chromosome i to take part in a crossover operation denoted by T_c. the probability of a chromosome i to take part in a mutation operation is denoted by T_m.

3.5. Crossover

The probability T_c of a S_i is calculated as follows

$$T_{S_i} = \frac{ff_f(S_i)}{\sum_{i-0}^{n} ff_f(S_1)} \quad (3)$$

$ff_f(S_i)$ Stands for the evaluation of the fitness function for the chromosomeS_i. The genetic algorithm is an Elitist algorithm where the best individuals always pass to the next generation. In this way probability of best chromosomes to be selected is greatly increased. Two point crossover are used which are denoted as T_{K_1} and T_{K_2}. Where $0 \leq K \leq 1$ and l is the size of the chromosome. The value of K_1 and K_2 are randomly chosen for each crossover operation and always $K_1 < K_2$. These points divide each chromosome into three parts namelyAG_j , $BG_j and\ CG_j$. The two new chromosomes are then obtained swapping $AG_{j,1}$ by$CG_{j,2}$, and $AG_{j,1}$ by$AG_{j,2}$.

3.6. Mutation

The mutation operation helps in generation of new population. Purpose of Mutation operation is to make small changes in chromosomes values. These changes consist of modifying one chromosome's bit. The position of the mutated bit is denoted by T_m . where 0 ≤ m ≤ 1. The value of T_m is randomly chosen for each mutation operation

3.7. Stopping condition

We choose population's average fitness function as the stopping condition of the genetic algorithm we denote $T_{av,j}$ as the population's average fitness function, and then stopping decision criterion can be formulated as

$$STOP_c \rightarrow T_{av,j+1} \leq T_{av,j} \quad (4)$$

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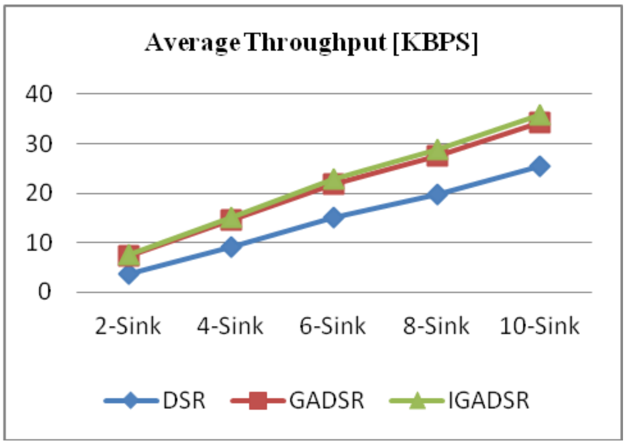
4. SIMULATION RESULTS

This section presents simulation results obtained for managing wireless sensor network parameters in disaster condition. Wireless sensor network parameters which are optimized are average throughput, packet delivery ratio, number of packets dropped, average end to end delay, average energy consumed. NS2 is used for simulation purpose. we have demonstrated these parameters under disaster conditions and enhanced these parameters by using genetic algorithm. Following performance metrics are considered for evaluation.

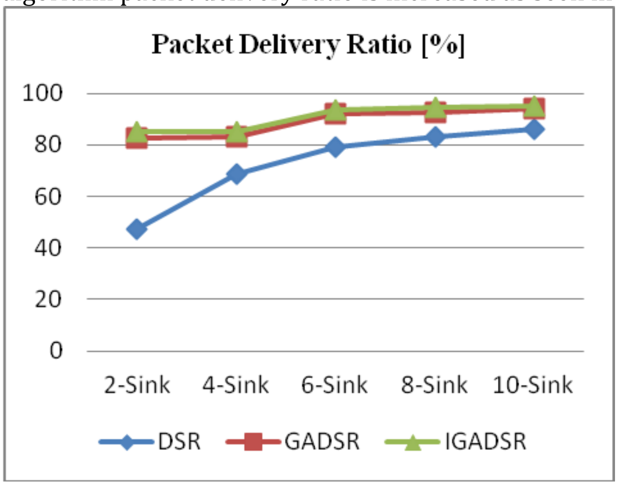
4.1. Throughput

This metrics calculates the total number of packets delivered per second, means the total number of messages which are delivered per second. Average throughput is increased as seen in graph in fig 2.



4.2. Packet Delivery Ratio (PDR):

The ratio of the data packets delivered to the destination to those generated by the sources. After applying genetic algorithm packet delivery ratio is increased as seen in fig3.



4.3. Energy Consumption:

The metric is measured to calculate the percent of energy consumed by a node with respect to its initial energy. The initial energy and the final energy left in the node, at the end of the simulation run are considered. The percent energy consumed by a node is designed as the energy consumed to the initial energy. And finally the percent energy consumed by all the nodes in a scenario is calculated as the average of their individual energy consumption of the nodes. We have improved genetic algorithm in order to minimize the average energy consumed which is seen in fig.6.

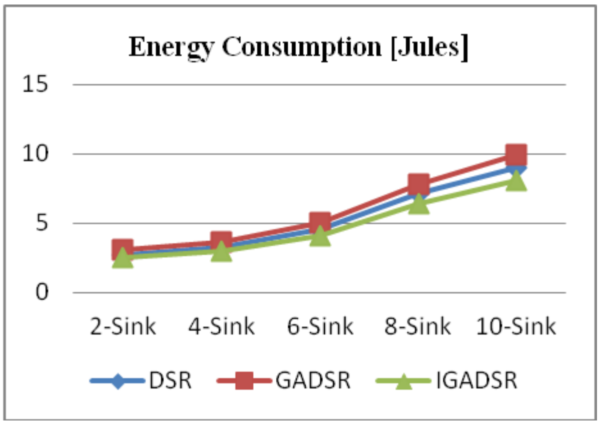


Fig.6.energy consumption

Simulation scenario details are shown in table 1

Paramter	value
Number of sensor nodes	220
Traffic patterns	CBR
Network size	1000/1000
Mobility speed	2 m/s
Simulation time	100 s
Transmission packet rate time	10 m/s
Pause time	1.0 s
Routing protocol	DSR/DDSR/DMDSR
MAC protocol	802.11
Transmission protocol	UDP
Number of sink nodes	2/4/6/8/10

Table.1.Network scenario

5. CONCLUSIONS

In this article we have presented an performance improvement technique of wireless sensor network using genetic algorithm. It helps for optimizing connectivity in disaster scenario. We have outlined design challenges first followed by Genetic algorithm as proposed approach for disaster Management.It is seen that performance of wireless sensor network becomes better and parameters are enhanced.

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BIOGRAPHIES

Mr. S. D. Chavan, working as Associate Professor M. E. (Electronics), Ph.D. (Research Scholar) Electronics Experience consists of 14 years of Academics and 5 years of Industrial experience. Professional Body membership includes LMISTE, MIETE.

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