A Hybrid Genetic Routing Algorithm in Wireless Sensor Networks

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Abstract. Wireless Sensor Networks (WSN) represent a new dimension in the field of networking. Through learning from the energy multi-path routing protocol of WSN and the hybrid genetic algorithm, this paper presents a novel routing protocol to find the optimal path. The Algorithm consists of two stages: single-parent evolution and population evolution. The initial population is formed in the stage of single-parent evolution by using gene pool, then the algorithm continues to the further evolution process, finally the best solution will be generated and saved in the population. The simulation results show that the algorithm is effective. It can optimize the network path, balance energy consumption of the network and extend the network life cycle.

Keywords: wireless sensor networks, routing protocol, network lifetime.

1 Introduction

In Wireless Sensor Networks, the energy of the node is limited, the maximum of the lifetime of WSN becomes an important goal to the design of the routing protocol [1]. However, the traditional routing protocol is little regard for the energy consumption, such as Flooding, Gossiping, and SPIN. Shah proposes an energy-aware routing protocol that improves the energy efficiency of the Directed Diffusion protocol, but it selected a path depending on the probability of random which lead to reliability decreased. Therefore, the routing protocols must consider not only the reliability of the optimum path, but also the energy consumption of the whole network.

In 1975, John Holland proposed a global optimization algorithm Genetic Algorithm (GA). In recent years, based on genetic algorithm in the WSN, routing optimization research is also very active [2]. For path optimization, genetic algorithms have shown a tremendous advantage. Based on the model of the energy multi-path routing protocol, this paper presents a new algorithm which abandons the randomness in the generation of initial population and replaces the gene fragments by gene pool. From simulation, the algorithm is effective and extends the network lifetime.
2 Hybrid Genetic Algorithm

Nowadays, in the stage of the whole evolution, the genes involved in genetic operator are mostly from the individual itself [3]. The quality level of the individual determines the efficiency of the algorithm. If the fitness of all individuals is poor, the algorithm performance will be affected. In order to overcome these weaknesses, this paper sorts $n$ points, constructs a $n \times n$ matrix of the gene pool, prepares for the genetic operators. This method greatly improves the efficiency of the algorithm.

2.1 Network Model

The network models as an undirected connection diagram $G (S, V, P)$, where $S$ on behalf of the node of the sink, $V$ presents the nodes. Set the nodes numbered 1, 2, 3... $n$, $P_k = V_1^kV_2^k...V_n^k$ for a feasible path, the first $k$ nodes of the path starting point is $V_1^k$, the aggregation node is $V_n^k$, then the total length can be expressed as:

$$f (P_k) = \sum_{i=1}^{n-1} PE (V_i^k, V_{i+1}^k) + PE (V_n^k, V_1^k)$$

$PE (V_i^k, V_j^k)$ is the energy consumption between the nodes, $f (P_k)$ is evaluated the individual's good or bad by using $P_k$.

2.2 Construction of Gene Pool

According to the cost between the nodes $PE (i, j)$, construct a $n \times n$ matrix $D = \{ PE (i, j) \}$, $num [i, j] = \{ j+1 : j \leq i \}$. For each node $i$, according to the size of $PE (i, j)$, the $num$ in the first line of the corresponding $i$ elements in accordance with the order from small to large order, and before all the elements $i$ come in, so will the expanded $num$ (increase in first column) to get a $n \times n$ of the square, gene pool is formed in this paper. Each row element in gene pool is the problem a feasible solution, the start node of the feasible solution is the line number of the gene pool [4]. Solving the problem is divided into single-parent evolution and the evolution of population. By single-parent evolution, the initial population $P = \{ P_1, P_2, ..., P_n \}$ is generated.