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Energy Efficient Particle Swarm Optimization Based Multipath Routing in WSN

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***Abstract*- Wireless Networks includes a larger advantage in today's communication application like environmental, traffic, military, and health observation. To realize these applications it's necessary to possess a reliable routing protocol. discusses about the working of proposed energy efficient bandwidth aware shortest path routing protocol for multipath routing in wireless sensor network. The proposed algorithm is based for choosing energy efficient shortest path. In routing algorithm, route that have shortest path among multipaths selected by particle swarm optimization algorithm. Among these shortest paths, that path is selected which require minimum route selection parameter. The proposed algorithm uses distance as well as energy of nodes as a parameter to find optimum paths using particle swarm optimization. Among these selected paths, only one optimum path is selected which reduces the energy requirement of the network. According to this work there would be improvement in other parameters also such as end to end delay as well as throughput.**

Keywords:- Wireless Sensor Network, Multipath Routing, Particle Swarm Optimization, Energy Efficiency.

I. INTRODUCTION

Recent developments in ad hoc wireless technologies have allowed wireless sensor networks to create spontaneous connections between devices with or without infrastructures [1, 2]. In addition, with the emergence of intelligent sensor-driven mobile devices, WSNs have become an essential part of the infrastructure of smart cities and the Internet of Things, with intelligent devices that can be customized and automatically configured by the WSN. send, receive and share data in an extremely restricted area (see Figure 1.2) [3]. In a highly intelligent environment, Wireless Sensor Networks (WSN) and Wireless Mesh Networks (WMN) are key technologies that provide many IoT applications and services to users. In addition, WSN has found a wide range of applications in the fields of health, battlefield communications, disaster recovery, crisis management organizations, ad hoc cooperative IT, social activities and conference rooms.

Despite the interesting applications of WSN, these systems still have to face numerous challenges and constraints that require further investigation before the commercial diffusion of WSN. The most important constraints on the design of WSN are: 1) limited battery life and duration, quality of service (QoS), configuration without infrastructure and dynamic network topologies, node mobility, reliability of wireless connections, functionality of variable nodes, scalability multi-hop routing, multicast support and security threats [4]. Therefore, the routing protocol plays an important role in these networks and the WSN constraints remain in the development of the latest routing protocols to modify the efficient transmission of packets on wireless support, mainly once the source and the destination are non-adjacent nodes. The routing protocol should choose the best path between source-destination node pairs in terms of power consumption and quality of service measurements such as available bandwidth, average end-to-end delay, packet loss and noise average. The reminder of this document is as follows.

Various approaches to high-speed, ad-hoc, and bandwidth multi-hop routing algorithms have been studied and adopted to reduce latency, delay and bandwidth of the connection and ensure a guaranteed level of application performance. sensitive to the quality of the service. Multipath routing is more

promising in ad hoc networks because it provides additional features such as load balancing, fault tolerance, higher throughput, etc. To ensure quality of service in ad networks. hoc.

Most of the routing protocols proposed for mesh and ad hoc networks are unipath, which means that only one route is used between a source node and a destination node. The main goal of multipath routing is to allow the use of numerous valid paths to reach destinations, not just the best way. This should be done without imposing excessive control over the maintenance of these routes.

The availability of multiple paths between an origin and a destination can be used to obtain the following benefits:

Fault Tolerance: the introduction of redundancy in the network or the provision of backup paths to be used in the event of a fault [11] are forms of introducing fault tolerance at routing level in mesh networks. To this end, some techniques can be applied as packet recovery [12, 13], which involves modifying the path of a packet if the actual path is interrupted.

Improved throughput: In a mesh network, some connections may have limited bandwidth. Single-route routing may not provide enough bandwidth for a connection. Therefore, using multiple paths simultaneously to route data can be a good approach to meeting the bandwidth requirements of some applications. By increasing throughput, you get a reduced end-to-end delay and improve service quality [14].

II. RELATED WORK

In [7], the authors present two approaches. First of all, a traffic load distribution technique is used to optimize the energy consumption of the nodes in a network topology with a base station in a corner. Subsequently, a distributed heuristic algorithm is proposed to combine load balancing with transmission power control to find the right traffic share between nodes to ensure an optimal balance of their energy consumption. However, this method works only for a raster topology.

In [8], the author proposed an energy efficient multi-channel routing protocol (EEMRP) that searches for various disconnected methods and uses a load equalization technique to influence traffic on a given route. The residual energy status of the nodes and therefore the variety of jumps are considered integrated in the function of connection costs. The connection cost function is used by the node to select the next hop during the route search phase. Because the EEMRP protocol only causes delays in the transmission of information, the reliability of successful paths is generally limited.

The authors of [9] proposed an EEPR protocol (Energy Efficient Path Routing) that reduces the variance of the residual energy of the nodes and increases the duration of the WSN network. The protocol selects a path based on the min-max formulation to find the residual energy path to reduce the variation in energy consumption. As a consequence, the duration of the WSN network also increases. It also chooses the path that is energy efficient and with maximum stability and reliability.

The work proposed by [10] by the author is a more recent variant of the AODV routing protocol that addresses the key issues in WSN, such as adaptability and energy efficiency. This is done by evaluating the energy values of the nodes and transmission packets along the path of the less drained nodes, thus making the network adaptable. Performance evaluation in terms of network duration, throughput, packet speed and end-to-end delay is performed using simulation tools such as NS2 / QualNet.

The authors of [11] suggested an improvement of the AODV protocol, which is an update of the current AODV protocol. The calculation protocol received from the effective remote ad hoc vector convention (EE-AODV) has improved RREQ and RREP, paying attention to the procedures aimed at preserving the vitality of mobile phones.

In [12], the author proposed a multipath routing algorithm based on the residual energy of the network. This setting is based on the number of hops in each node to find the easiest path and place it in the routing table. The main idea of this algorithm comes from the ant colony optimization (ACO).

In [13], the author proposes a new protocol called Efficient Power Aware AODV. This work is a combination of two previously proposed works which are a modification of the normal functioning of the widely used and well-known ad-hoc remote vector routing protocol.

III. PROPOSED METHODOLOGY

What we describe here is our contribution to define multiple routes between a given nodes and the source node (eventually the sink node) by selecting a subset of all existing routes. The route selection is dependent on node density and remaining energy.

This section discusses about the working of proposed energy efficient bandwidth aware shortest path routing protocol for multipath routing in wireless sensor network. The proposed algorithm is based for choosing energy efficient shortest path. In routing algorithm, route that have shortest path among multipaths selected by particle swarm optimization algorithm.

Among these shortest paths, that path is selected which require minimum route selection parameter.The flow chart of proposed algorithm is discussed below:

Steps of Proposed Algorithm

Step 1: Send RREQ from source node

Step 2: Receive route reply from neighbor nodes

Step 3: Establish different paths from source to destination

Step 4: Calculate shortest path based on distance and remaining energy of the nodes in the path using particle swarm optimization

Step 5: Select multiple shortest path from network

Step 6: Calculate route selection parameter of each node in the selected shortest path

Step7: Select one among different shortest paths whose selection parameter value is minimum.

Step 8: Forward Data packets

According to above steps one of the important functions is to find multiple shortest paths using particle swarm optimization which is discussed below:

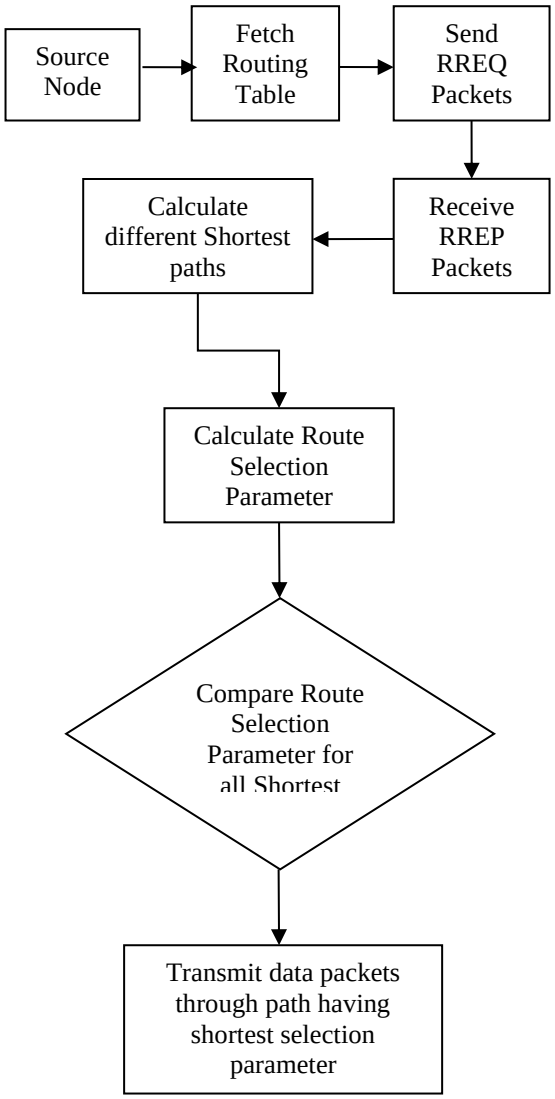

Figure 3 Proposed Algorithm Flow Chart

Particle swarm optimization based shortest path selection

Particle swarm optimization is mainly a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to given measure of quality

For solving any optimization problem we have to first formulate the problem according to optimization problem.

In this proposed algorithm the best path is chosen according to fitness value which is according to the minimum distance to be travelled by a data up to base node as well as energy of the node.

Fitness Function

To find optimize path using PSO, need to find the fitness value of each path.

$$Fitness_{val} = dist(i,j) + remaining_{energy(i)} + remaing_{energy(j)}$$

This fitness value will be used to select the local best and global best for PSO. The path having minimum fitness value will be the best optimal solution.

Calculation of route selection parameter

For calculating the selection parameter Source Node, Destination Node Transmission Range and power loss acts as an input. The route selection parameter is estimated as below in equation:

$$R_{sp} = \frac{P(tx)d^{-\alpha}(i,j)}{\sum_{k=1}^{N} P(tx)d^{-\alpha}(i,j) + \sigma^2}$$

Where, *P(tx)* = Transmission Power
$d^{-\alpha}$ (i,j) = Distance between node i and j
σ = Power level of noise
α = Path loss components

The Advantages of Proposed Approach are End to End Delay is less, Energy consumption is reduced due to fact that the routes that are discovered are very less. The algorithm takes route selection parameter based on power requirement and bandwidth requirement of the route to pick the forwarding nodes or forwarding link hence the throughput is high because the route chosen is bandwidth aware.

IV. CONCLUSION

In this paper an energy efficient multipath routing algorithm is proposed. This algorithm is used to find optimum path among all shortest path discovered which utilizes the minimum energy of nodes and thus wireless network remains for long time span. The proposed algorithm uses distance as well as energy of nodes as a parameter to find optimum paths using particle swarm optimization. Among these selected paths, only one optimum path is selected which reduces the energy requirement of the network. According to this work there would be improvement in other parameters also such as end to end delay as well as throughput. In future work, this proposed algorithm would be implemented and experimentally proves the efficiency of the system with respect to existing systems.

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