Energy Efficient Multi-Path Routing in MANET's Using Swapping of Nodes and by Load Balancing of Data Packets on to the Nodes

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Article History: Received: 10 November 2020; Revised 12 January 2021 Accepted: 27 January 2021; Published online: 5 April 2021

Abstract: To conduct multiple routes in a mobile Ad-hoc network (MANET) in order to balance the load onto nodes and make nodes more energy efficient. As the battery life of a node rises, swapping of nodes is done to make the network more dependable. In this case, the best fit function will be utilized to exchange two totally suitable nodes. Initially, the system develops a self-configuring network with mobile nodes and no fixed infrastructure. After constructing the network, a multi-path source and destination are chosen for data transmission. After that, a multi-path is discovered for transferring the data, and the shortest way is determined based on node energy and distance. After that, the energy consumption of each node is determined, the node with the lowest energy level is exchanged with the node with the highest energy level using the swapping algorithm, and data is sent to the destination node. The battery usage increases as the load on the destination node increases. Priority sequencing should be used for data cluster formation in order to minimize node battery failure and excessive energy usage.

Keywords: Wireless Sensor Networks, Swapping Of Nodes, Load Balancing, Multipath Routing

1. Introduction

Wireless sensor networks (WSNs) have gained a lot of attention in recent years because of their numerous applications in tracking and monitoring. WSN's applications in the industrial, biological, environmental, military, agricultural, local, and business domains are expanding. A wireless sensor network in which the sensor nodes are mobile is known as a mobile ad-hoc network. There are two forms of mobility in these networks: automated mobile networks and manually managed mobile networks. The tactical MANET, for example, is a type of automated MANET that is widely utilized in current military forces, particularly for the autonomous movement of unmanned vehicles and robots [10].

An ad-hoc network is a collection of wireless mobile nodes that operate together by forwarding packets to one another, allowing them to connect outside of their immediate wireless range [8]. The nodes that participate operate as routers and are free to roam throughout the network at will and control themselves. The wireless topology of the network may change quickly and without warning. The mobile nodes are powered by a limited-energy battery, which is frequently hard to replenish or replace at a distant location. Wireless communications need a substantial amount of battery power [1]. Routing is the process of determining different paths between source and destination nodes. All routes are determined before being reconnected to the network. Static Routing and Dynamic Routing are the two types of routing tables. Dynamic routing is a networking strategy that delivers effective data routing, while static routing is a form of network routing strategy. Additions and removals of routers have no effect on the routing table in static routing, but they do in dynamic routing. The energy and longevity of a network are degraded as nodes [3] and connections are moved around.

In this work, we look at the literature review in section II, the proposed method modules in section III, mathematical modeling, algorithm, and experimental setting. Finally, in section IV, we present a conclusion.

2. Literature Review

They provide an optimum energy strategy for ad hoc networks in [1] this study (MANET). Transmission power, interferences, link longevity, and load balance were all factors taken into consideration. For resolving traffic congestion and picking a minimal power path, a load balancing strategy is employed to distribute traffic over the various routes. They use an algorithm known as OELR for load balancing and energy optimization.

In [2] resource limits are a fundamental challenge in ad hoc networks, and this study proposes ways for redistributing server load from one server to another. In ad hoc networks, energy efficiency is the biggest issue. They use multipath routing techniques to shift the load from a low-energy node to a high-energy node in this procedure.

Bhavna Sharma and Shaila Chugh [3] are packet routing systems that use load balancing, energy conservation, and shortest path approaches. Energy based multipath routing (E- AOMDV) schema is used by people who want to save energy. The suggested E-AOMDV has a shorter life span than AOMDV without the energy element, but it provides better routing.

They introduce a priority queue scheduling method for Mobile Ad Hoc Network (MANET) called energy-efficient and load balanced queue scheduling algorithm (ELQS) by Jiangtao Yin and Xudong Yang [4]. They are considered parameters such as capability cost, a consequence of one mobile node's congestion level and energy use, and it is separated into three separate phases Min and Max two thresholds, in order to reduce heavy traffic loads. ELQS reduces network transmission latency, according to the results.

For boosting packet delivery ratio, Xiaoying Zhang and Alagan Anpalagan [5] present the energy-aware load-balanced routing (EALB) method. In heavy load networks, it also minimizes the latency and extends the network lifetime. In networks with high traffic loads, EALB achieves greater PDR, lower latency, and longer network lifespan than classical AODV and DSR.

MANETs (Mobile Ad-hoc Networks) are beneficial in a variety of situations because they allow for multi-hop communication without the need for wired infrastructure. However, an issue exists in that even a single independent obstruction on the whole channel can severely reduce the network throughput of a flow. Using a diversion path that avoids local congestion is one approach to the problem. To this aim, the detour pathways should avoid using nodes in the crowded area, which, depending on the nature of radio waves, is really rather extensive. Such alternative-path calculation methods do not now exist in the state-of-the-art. We designed an approach and a routing strategy in this study for calculating and utilizing detour pathways adaptively based on network traffic circumstances. We demonstrate that the proposed strategy improves communication performance by exploiting detour pathways in real-world network environments [6] through assessment.

In [7], a novel method was created by combining the Ad-hoc on Demand Distance Vector (AODV) with the Cross Layer Design method. The method is known as the Congestion Control AODV (CCAODV) technique. It is employed in MANET to prevent link failure. The intensity of the received signal is employed as a proposed routing parameter. Using the signal strength of the node, the CCAODV protocol builds a robust and reliable route. The signal intensity is primarily determined by elements such as the node's transmission power and the difference between the two nodes. The Ns 2.35 simulator is used to evaluate the cross-layer design technique, which is then compared to the Routing algorithm.

Wireless Sensor Technology is one of the most rapidly developing technologies in the current environment, with a wide range of applications that include compact sensors with little communication and computing power. The energy consumption of a node changes depending on the node's overhead. This results in a non-uniform distribution of energy, which lowers the network's overall performance. For recognizing the low level energy node, the Swap Rate algorithm (SRA) is applied. Furthermore, the nodes are recognized even when the network is disrupted by other factors. In the recovery approach, a node in its immediate area detects a low-energy node and updates the sink node, which then sends a nearby node with a high energy level to restore the node. It will take the position of the node, and data transfer will ultimately be possible without any impediments, ensuring network dependability [8].

The authors of article [9] offer a tactical MANET architecture that includes the MAC and Network layers for unmanned autonomous maneuver networks. It allows you to create a multi-hop ad hoc network.

3. Proposed Approach

3.1 Proposed System Overview

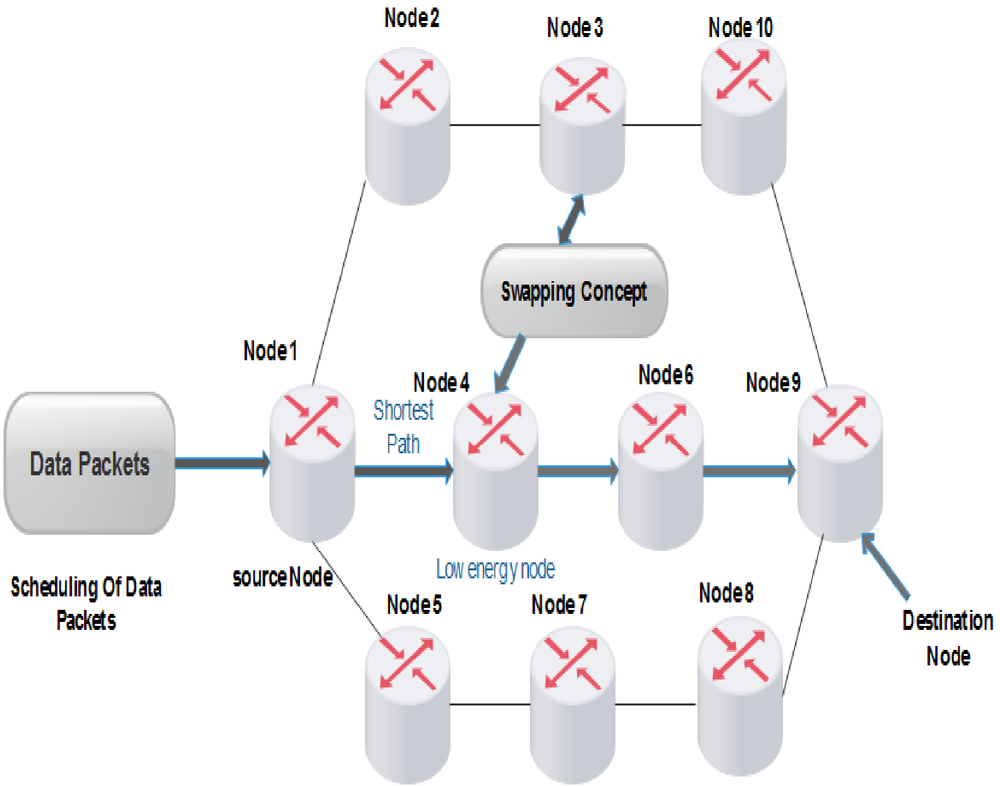

Fig 1: System Architetcure

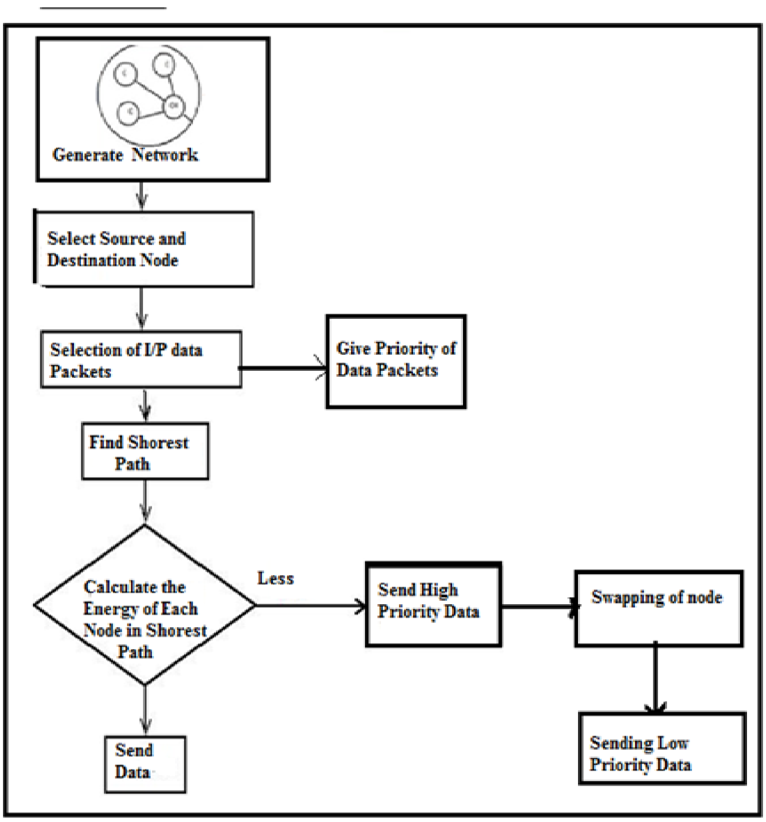

Fig 2: System design

Techniques used to implement this system:

1. Network Generation

Initially random network is generated; node position in random network is not fixed.

2. Select Source and Destination Node

Network creation the selection of source node and destination node.

3. Find the Path

Depend on the source node and destination node generates the multiple paths from source node to destination node.

4. Search Shortest Path

Next step is to search the shortest path among the multiple paths to send data.

5. Energy Value Calculation

After finding shortest path calculate the energy of each node of shortest path, if node energy is sufficient to data transfer then data transfer from source to destination here for this use low priority data and high priority data

6. Swapping of Node

If node energy is not sufficient to data transfer then checks the neighbor path node energy, if there is sufficient energy to data transfer then swapping of node is perform.

7. Send Data

After selecting the shortest path with energy efficient node then send the data from source node to destination node.

3.2 Algorithm

a) Algorithm 1: Multipath Route energy base route for Load Balancing Algorithm

1. Set M Mobile Node's
2. Set S sender and R receiver Node
3. Set Initial Energy = E // *for all node energy is different value*
4. Broadcast Route

```
        {
                If (route from S to R found)
                {
    Check High Priority Route;
     If (route => 1)
       {Find (energy of each route && energy > 0)
       Select High Priority Route      //shortest path
     Send high priority data          }
          }
     Else {route unreachable}
         }
```

5. Send data through selected path

3.3 Mathematical Model

Input - Wireless Link Model with N number of nodes.

Output- Energy efficient and load balancing network

Process 1:

Calculate capacity of wireless link

c(l) =W(l) $\log_2$(1+ (l))

where,

w(l)= Channel bandwidth at link l

θ(l)=SINR

$$\theta(\mathrm{l}) = \frac{\mathrm{G}(\mathrm{T}(\mathrm{l}), \mathrm{R}(\mathrm{l})\mathrm{P}(\mathrm{l}))}{\sigma_{R(l)} + \sum_{m:m\neq l} P(m)G(T\ (m), R(l))}$$

$\sigma_{R(l)} = \sigma_{R(l)}$ = P(l) =transmission power at node T(l),

G(T(l),R(l)) =path gain between the transmitter and receiver

Process 2:

Find Path:

By using Dijkstra's algorithm + Energy factor

d(S,R)=v from S to R with minimum distance and

$v \in V$ and P(l) is high.

S=Sender

R=Receiver

v=vector

V=all vector in graph

Process 3:

Calculate transmission power

P=(P(l)................P(L))^T

P= power vector i.e transmission power for each link

L=number of links in the network.

Process 4:

$$P \geq FP + b$$

where FP= Interaction power vector

b=bandwidth is (b(l)..........b(l))^T

Process 5:

Mobility factor:

$$V = \frac{d}{Time}$$

MF=P(mV)^2

m= Mass

V=Velocity

P_r=Power required for mobility at time T to V.

Process 6:

Load Balancing:

- Send high priority data.

RET=min (LET_i,s............LET_{jin})

S= Source path P

i={i,i_2........i_n} Set of upstream to node j

RET= Active path that j support during time period P.

- Low priority data

Calculate number of active path for any nodej $+ 1 \in P$

$$RET_{j+1} = \max\{N^{act\ P} \times \frac{RET_{j+1}}{RET_i}, N_{j+1}^{act\ P}\}$$

$N_{j+1}^{act\ P}$= Number of active node with power vector

Success: $0 \leq P \leq P^{max}(l)$

Failure: $P > P^{max}(l)$

3. 4 Algorithm

1) Deployments of nodes   N (n).

2) Select source S (n) to destination node d(n)

3) Select i/p data packets DP (n)

4) Give priority to data packets DPH(n), DPL(n)

DPH(n)= High priority to data packets

DPH(n)=Low   priority to data packets

5) Find the shortest path from multiple path SP(n);

6) Calculate threshold energy ET (n) to send data to next instant.

ET (n)=Distance/Energy =D/E(n)

7) If node energy E(n) =ET(n)

Data packet send to destination

else

find the neighbor high energy node EN(n)

8) High priority data packets DPH(n) send through Existing path i.e shortest path.

9) Swapping of node

E(n)=ET(n)

10) Low priority data DPL(n) send through nearest path except shortest path.

4. Result and Discussion

4.1 Experimental Setup

The system is based on the Java foundation and runs on the Windows operating system. As a development tool, the Net Beans IDE is employed. The application does not require any special hardware to run; it can be run on any regular computer.

4.2 Expected Result

In this section we discussed about the energy consumption of the network for the proposed system and existing system. Energy of network is calculated as:

ETX (l, d) = ETX-elec (l) + ETX-amp (l, d) =

$$\begin{cases} E_{elec} * l + \varepsilon_{fs} d^2 * l & d < d_0 \\ E_{elec} * l + \varepsilon_{amp} d^4 * l & d < d_0 \end{cases}$$

In this section shows the energy calculation by using the above formula for different number of nodes. We plot graphs for all the different values shows in figure 3. Energy Required For Each Node Which Is In Shortest Path Is Compared

1. AODV 2.Swapping +Priority Scheduling

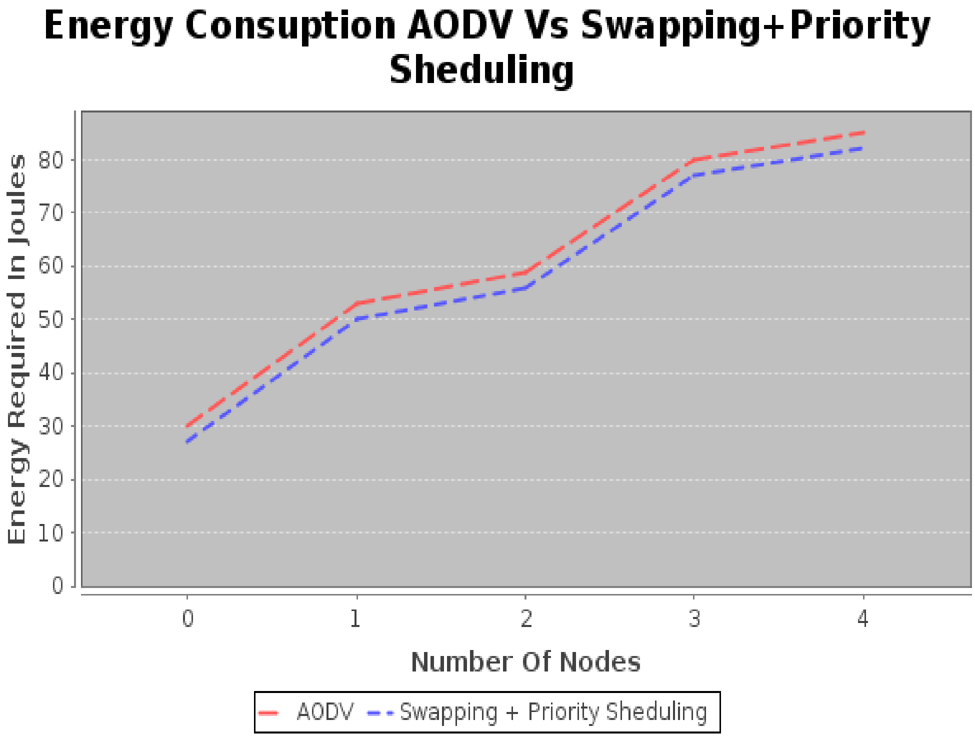

Figure 3. Energy Consumption Graph

Fig 4 Shows that Energy Graph For Only Swapping Of Node System. Proposed system are more accurated than the existing system.

1.Initial Energy- Starting Enegy Of Node

2. End Energy- Remaining Energy

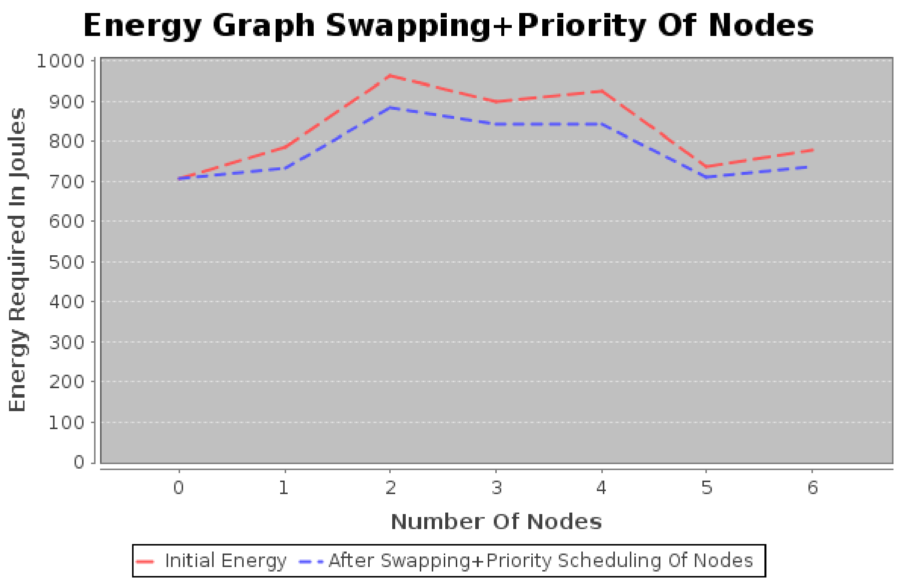

Figure 4. Energy Graph

Fig 5 Shows that Time graph. Proposed system are more accurated than the existing system.

Time Required For Total Data Sending Is Comapred
1.AODV
2.Swapping +Priority Sheduling

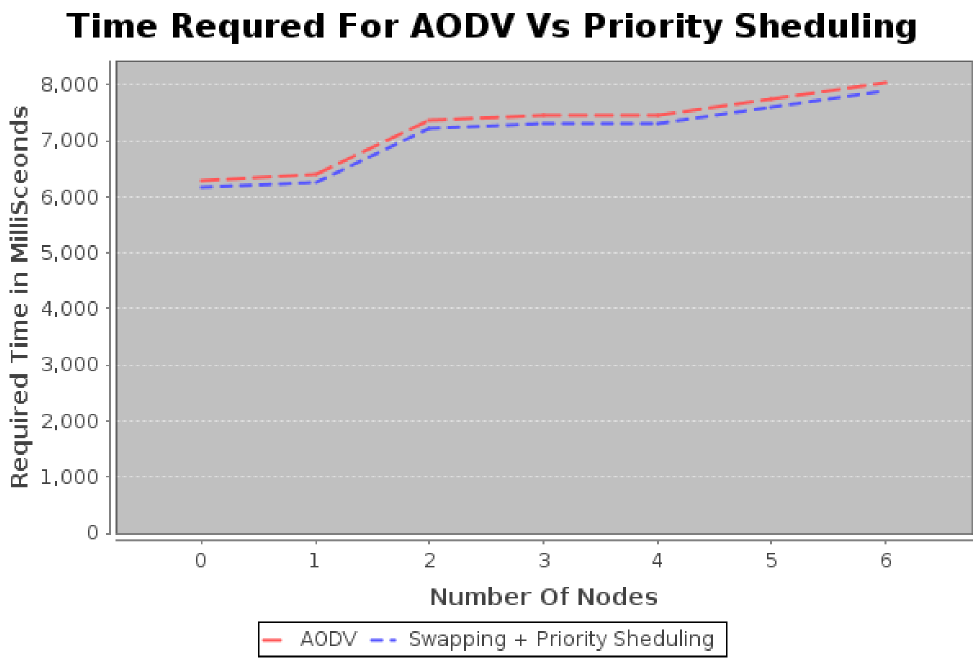

Figure 5. Time graph

5. Conclusion

The suggested technique enhances the wireless sensor network's network lifespan by introducing the methods of Swapping and priority Scheduling, which reduce network energy consumption and raise the wireless sensor network's network lifespan and packet delivery ratio. When the load is correctly distributed, energy consumption rises, and high-priority data is sent.

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