МОДЕЛИРОВАНИЕ И АНАЛИЗ СЛОЖНЫХ ТЕХНИЧЕСКИХ СИСТЕМ

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WIRELESS SENSOR NETWORKS ENERGY EFFICIENCY ENHANCING

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Wireless sensor networks (WSN) [1]-[6] are consisting of sensor nodes that are connected through a wireless media. Multi hop transmission is occurring to route the data from the source to destination. Large number of sensor nodes can deploy in environment that assemble and configure themselves. A tiny sensor device has the capability for sensing, computation, and communication into other device. WSNs are used to monitor and measure the environmental conditions like temperature, humidity, sound, pollution levels, pressure etc. The energy efficiency is a most challenges in multimedia communication due to the resource constraints, efficient channel access and low transmission delay. The energy efficient routing is a key research area in wireless sensor networks for dynamic topology nature property. Therefore we need to design the effective routing protocols. In recent days, various energy efficient routing protocols have been proposed for WSNs [7]-[9].

In recent days, researchers have proposed various routing schemes [10]-[12] for enhancing real time properties of WSNs to provide reliable transmission. In that one hop information is used to select forwarding nodes. Two hops velocity based routing (THVR) algorithm [14] was introduced to diminish the deadline miss ratio that uses geographic information that provide optimal path to forward packets to the destination. Recently, the work [13] proposed protocol for on demand Multi hop information based multipath routing (OMLRP) that offered on demand acquisition of neighborhood information around data forwarding paths. It reduces the message exchange overhead than THVR. By combining OMLRP and a gradient based network, the optimal path and energy efficiency is achieved. This paper combined these two approaches for achieving optimal reliable routing.

Gradient Based Network Setup take the minimum hop count and remaining energy of a node while routing data from source node to the sink. The optimal route is established autonomously, the scheme is composed of three sections discussed in [14], [15]. It can optimize the transmission energy and reduce the energy consumption of each node to prolong the network lifetime. In this sink broadcasts a packet which contains a counter set to 1 initially. After receiving a packet, the receiving node sets its height equal to the counter in the packet and increases the counter by 1, then forwards the packet.

The sink sets its height to 0. The heights of other nodes are equal to the smallest number of hops to the sink which is reduced the routing overhead because it select the minimum hop to involve the routing.

Data forwarding approach. Each node calculates joint parameters for forwarding the packets to sink. A node compares with its joint parameters to neighboring nodes and selects a neighbor to relay its packets to the sink. It is considered both the semi minor axis of the elliptical region denoted by H_e and node energy is defined from the following expression:

$$H_e = \frac{D(s,d)}{2h} + \gamma \frac{E_j / E_j^0}{\sum_j \left(E_j / E_j^0\right)}, \quad h \geq 1, \tag{1}$$

where coefficient $\gamma \in [0,1]$. The maximum value of γ indicates that end to end delay, the minimum value of γ leads the traffic to nodes with higher remaining energy. E^0 is the initial energy of node; E_j is the remaining energy of node. The Fig. 1 shows that Elliptical region of source and destination to select the neighboring node for forwarding packets.

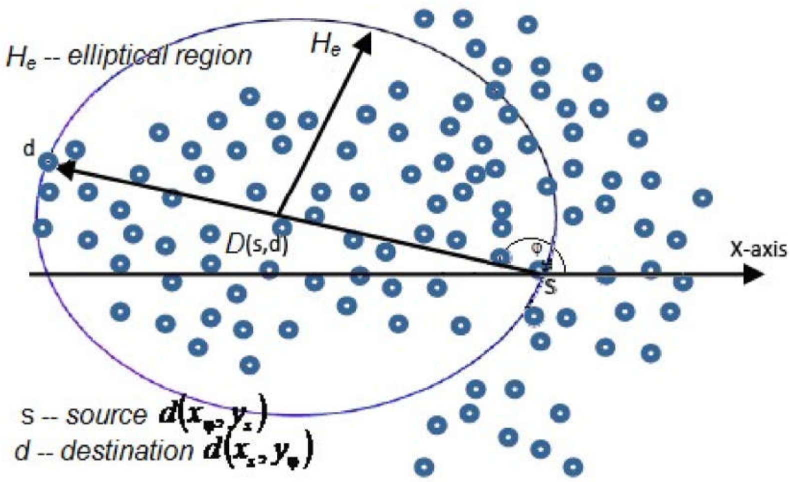

Fig. 1. Elliptical region of source and destination

Acknowledgement mechanism is applied to calculate the delay of the packets. A node will stamp the time to identify the delay of packets of each node, when it receives the packet and then compare it with the time when the ACK packet is received. The delay estimation of T for time instant (T+1) is calculated by (2)

$$\tau_i^j(t+1) = \alpha M_i^j(t) + \frac{1-\alpha}{T} \sum_{k=\max(1,t-T)}^{t-1} \tau_i^j(k) \tag{2}$$

where T is time window, $0<\alpha<1$ is the configurable weighting coefficient. M^i is the newly measured delay which is defined by larger value of α. This Gradient Based Network Setup is then combined with OMLRP to make energy efficiency in WSNs which improves the network life time.

On Demand Multi Hop Information Based Multipath Routing. OMLRP considered the following assumptions for real time routing which is followed from [16], [17]. The assumptions are as follows:

- Homogeneous sensor nodes are deployed in the network.
- Global positioning system is used by each sensor node to aware of its location in the field.
- One of them initiates to generate packets that became the source node.

This approach performed multi hop look ahead around the paths from the source to destination within an elliptical region. It selects an optimal path among multiple paths [18] within the elliptical region. The Fig. 2 shows that on demand Multi-hop information based Multipath routing with in elliptical region with $K_{hop} = 4$. A multipath algorithm is obtained from [19], [20] that select multiple routes from source to destination within elliptical region with high link quality and low latency. In this, a node sends its packets to neighbors through multiple alternative paths. Optimal path is selected for data transmission from source to destination. If a problem occurred in selected path, it select next available shortest path for forwarding data to destination. The elliptical region is restricted the look ahead around the packet forwarding path for reliable routing. The elliptical region is calculated using location information of the source and the destination from GPS systems [21]. When the source node starts for forwarding the packet to the destination, the multi hop look ahead is triggered within the restricted elliptical region. The elliptical region is calculated by using location of the source node $s(x_S, y_S)$ and destination node $d(x_d, y_d.)$ from the well-known expression:

$$D(s,d)=\sqrt{(x_d-x_s)^2+(y_d-y_s)^2} \tag{3}$$

where $D(s, d)$ is a distance between source node s and destination node d.

Look Ahead Algorithm. As A sensor node can distinguish whether it is within the elliptical region determined by the function (4). Look ahead algorithm is used to found out each sensor node located within elliptical region.

Algorithm:

1°. Sensor node N_a determine its location (x_a, y_a)

$$X = X_a\cos\varphi + Y_a\sin\varphi \tag{4}$$

$$Y= -X_a\sin\varphi + Y_a\cos\varphi \tag{5}$$

2°. N_a calculates $f(x, y)$ from (4) and (5)

If the $f(x, y) > 0$

N_a is located at out of the elliptical region.

If the $f(x, y) <= 0$,

N_a is located within the elliptical region.

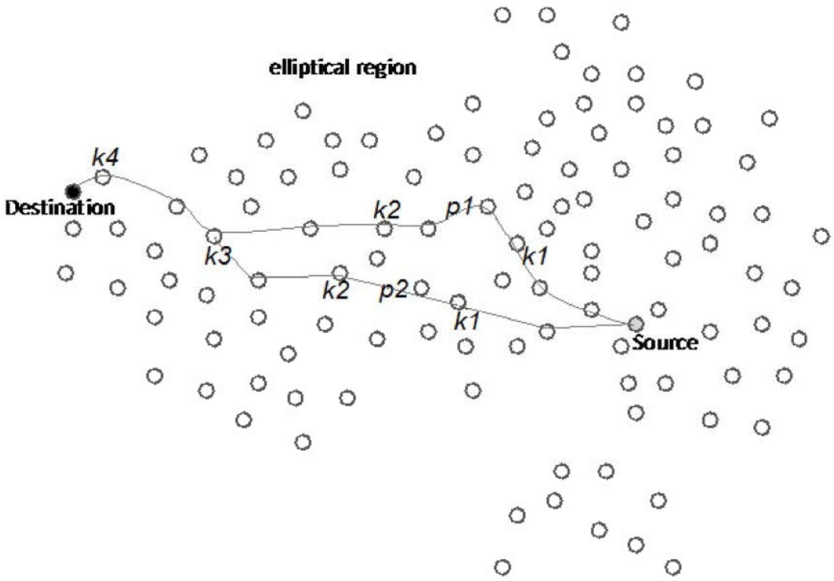

Fig. 2. On demand Multi-hop information based Multipath routing within elliptical region with $K_{hop} = 4$

This algorithm provides an effective way to retain the energy efficiency and scalability. A hybrid metrics such as link quality and latency are used as the criteria for optimal path selection. Look ahead message mechanism is used which includes five tuples (K_{hop}, $s(x_s, y_s)$, $d(x_d , y_d)$, H_e, R), where K_{hop} indicates no of look ahead hops; $s(x_s, y_s)$, $d(x_d, y_d)$ – indicate location of source and destination nodes respectively; H_e is the elliptical region specified by expression:

$$H_e = \frac{D(s,d)}{2h}, \ h \geq 1, \tag{6}$$

where $D(s, d)/2$ is the semi axis of the elliptical region and h is the size of the elliptical region.

It calculates average speed of every path from the source to the destination until K_{hop} for selecting optimal path. R is a selected optimal path among multiple paths from source to destination within the elliptical region based on multi hop look ahead mechanism. Fig. 2 noticed that the on demand Multi hop information based Multipath routing with in elliptical region with $K_{hop} = 4$. If $K_{hop} = 4$, every node in an elliptical region maintains location until four hop neighborhoods. From Equation (6), if h is 1, the elliptical region is a circular region between s (x_s, y_s) and d (x_d, y_d) and h value may be dynamically determined by system. The traffic load balancing is performed in the previous real time protocols [22]. Source and forwarding node can deliver data to a destination using selected optimal path that satisfy a desired speed and also perform traffic load balancing which make even energy consumption by all nodes.

This paper, a radio hardware energy dissipation model was used where the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics. Thus, to transmit a k-bit of message and distance d, the radio expends

$$E_{TX}(k,d) = E_{TXe}(k) + E_{TXa}(k,d). \quad (7)$$

To receive *k*-bit message, the radio expends

$$E_{RX}(k,d) = kE_{TXe}, \quad (8)$$

where E_{TXe} is electronics energy for receiving k bit message, E_{TXa} is amplifier energy that depends on the distance to the receiver.

In this paper, an energy efficient optimal gradient based routing protocol is proposed which is combination with OMLRP and a gradient based network that is achieved through optimal routing path and reduces energy consumption of senor nodes.

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