IMPROVED ROUTING TECHNIQUE USING ZIGBEE NETWORK: AN ANALYTICAL STUDY

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ABSTRACT

ZigBee is a wireless network standard based on IEEE 802.15.4. It is a wireless sensor network technology its main characteristics are low transmission range, data rate, price and power consumption. The aims of this network are to reduce the energy consumption and latency by enhancing routing algorithm. In a traditional tree routing when a node wants to transmit a packet to the destination, the packet has to follow child/parent relationship and go along tree topology, even if the destination is lying at nearby source. In order to solve this problem, an Enhanced Tree Routing Algorithm is introduced using ZigBee network. This algorithm can find the shortest path by computing the routing cost for all of router that stored in neighbor table, and transmit the packet to the neighbor router that can reduce the hop count of transmission. The enhanced tree routing algorithm can achieve more stable and better efficiency then the previous traditional tree routing algorithm. There are various goals of present study like studying routing techniques using ZigBee network, design of enhanced routing algorithm for routing the packets and comparison of traditional and enhanced tree routing algorithms.

Keywords: *IEEE 802.15.4, ZigBee, Neighbor-Table, Tree Routing.*

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1. INTRODUCTION

Routing of packets in a ZigBee network has many advantages over traditional routing. Despite of all the constraints of ZigBee network (low transmission range, low data rate, low price and low power consumption) it has many application areas like light meter sensor, temperature & humidity sensor, remote monitoring, home control, and industrial automation. ZigBee network standard was created by ZigBee Alliance. ZigBee Alliance is an association of companies working together to enable reliable, cost effective, low power wirelessly networked. It is composed of 200 members company and also includes 14 promoters such as Motorola, Philips and Samsung. Wireless technologies are designed to run for hours or perhaps days on batteries, ZigBee is designed to run for years. ZigBee routing involves the several issues like Maintaining routing tables in order to remember best available routes, initiate route discovery on behalf of higher layer, initiate route discovery on behalf of other ZigBee Router, initiate end-to-end route repair, initiate route repair on behalf of other ZigBee Router, participate in route discovery on behalf of end devices and participate in local route repair.

In this project, we try to solve the problem of routing the packets from source to destination by employing Enhanced Tree Routing algorithm. This algorithm will use neighbor table to find the shortest path between various hops of a network.

2. PROBLEM DEFINITION

The proposal of the paper is to implement Enhanced Tree Routing algorithm using ZigBee network. This network has been used because of its characteristics. Several cases will be discussed in the algorithm like (i) Destination is parent of source (ii) Destination is source's descendent (iii) Destination is its neighbor (iv) Destination is its neighbor's descendent or parent.

3. JUSTIFICATION

The topic of study is of great importance in present time because cost of routing is always a costly affair. If we can reduce the cost of sending a packet from source to destination, then this will help to improve network substantially. Using ZigBee network, Enhanced Tree Routing algorithm helps to reduce routing cost of packets and it also gives robustness to the network.

4. ENHANCED TREE ROUTING ALGORITHM USING ZIGBEE NETWORK

4.1 Problem with Tree Routing Protocol

The main drawback of tree routing protocol is that it uses only the parent/child relationship for routing, ignoring neighbor nodes. As a result, packet may be routed through several hops towards the destination even if the destination is situated nearby the sender as seen in the figure.

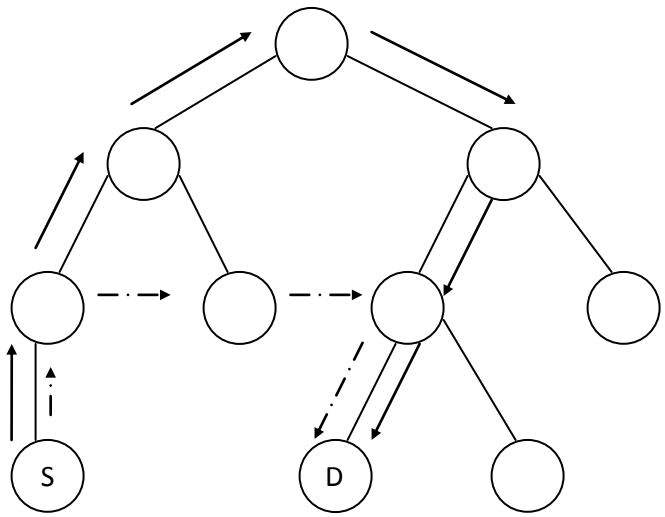

Figure 1: Problem with Tree Routing Protocol

The advantage of tree routing is that it is simple and not requires routing table.

4.2 Algorithm for Tree Routing

```
If (D>S)
        Next hop = Move Downward along the Tree
Else
    Next hop = Move  Upward along the Tree
End If
```

4.3 Enhanced Tree Routing Algorithm

This algorithm removes the shortcomings of TR algorithm. In this algorithm when source node wants to send some packets to its destination, it may encounter one of the following cases:

Case 1: Destination is parent of source

The source node checks if its parent node is the destination node. If yes, then it will transmit the packets to the parent and stop.

Case 2: Destination is source's descendent

The source node checks if the destination address is one of its descendants. If yes then it will transmit the packets to its descendant. Then it checks if the descendent is the destination. If yes, it means destination is found therefore stop.

Otherwise, the descendent will search for the destination in its own descendents until the destination found.

Case 3: Destination is its neighbor

The source nodes checks if the destination address is one of its neighbors.

If yes, then it will transmit the packets to the neighbors and stop.

Case4: Destination is its neighbor's descendent or parent

The source node checks if the destination address is one of its neighbor's descendents. If yes, it will transmit the packets to the neighbor. Then the neighbor will find the destination among its descendents.

If the destination is not found then check the neighbor's parent up to the coordinator until the destination found.

Algorithm: ENHANCED_TR (T, S, D)

// S=Source, D=Destination, Par=Parent

Step 1: Source node checks if the destination node is its parent node

If D = = Par

Transmit packet to the par and exit

[End If]

Step 2: Source node checks if the destination address is one of its descendants

If descendent = = D

Transmit packet and Exit

Else

Set descendent as source

Repeat the step

[End If]

Step 3: Source node checks if the destination address is one of its neighbors

If D < S

Check Left neighbor

Else

Check Right neighbor

[End If]

If the destination address is found in neighbor

Transmit the packet to the neighbor and exit

[End If]

Step 4 Source node checks if the destination address is neighbor's descendent or parent

If the destination address is one of its neighbor's descendents.

Transmit the packet to the neighbor

Set neighbor as source

Else

Check the neighbor's parent

If destination found

Transmit the packet and exit

[End If]

[End If]

4.4 Simulation of above cases

Case 1: Destination is parent of source

The source node checks if its parent node is the destination node. If yes, then it will transmit the packets to the parent and stop.

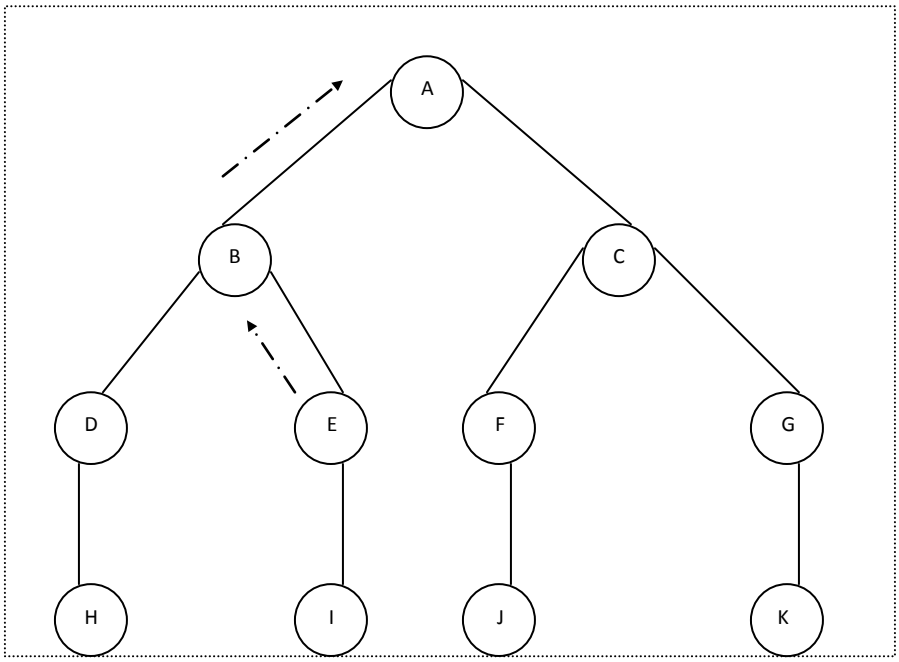

Figure 2 : if parent is the destination

According to the above example if node A i.e. parent node is the destination node. If yes, then it will transmit the packet to the parent and stop.

Case 2: Destination is source's descendent

The source node checks if the destination address is one of its descendants. If yes then it will transmit the packets to its descendant and stop. Otherwise, the descendent will search for the destination in its own descendents until the destination found.

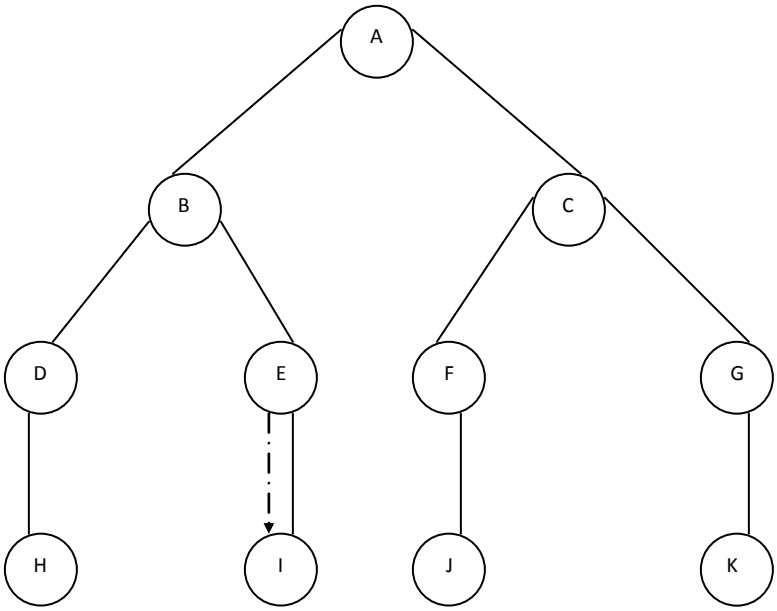

Figure 3: - if descendent node is the destination

According to the above example if the node E is our source and the node I is our destination then the source node send the packet to its descendent and stop. Otherwise, the descendent will find for the destination in its own descendents and the process is repeated until the destination found.

Case 3: Destination is its neighbor

The source nodes checks if the destination address is one of its neighbors.

If yes, then it will transmit the packets to the neighbors and stop.

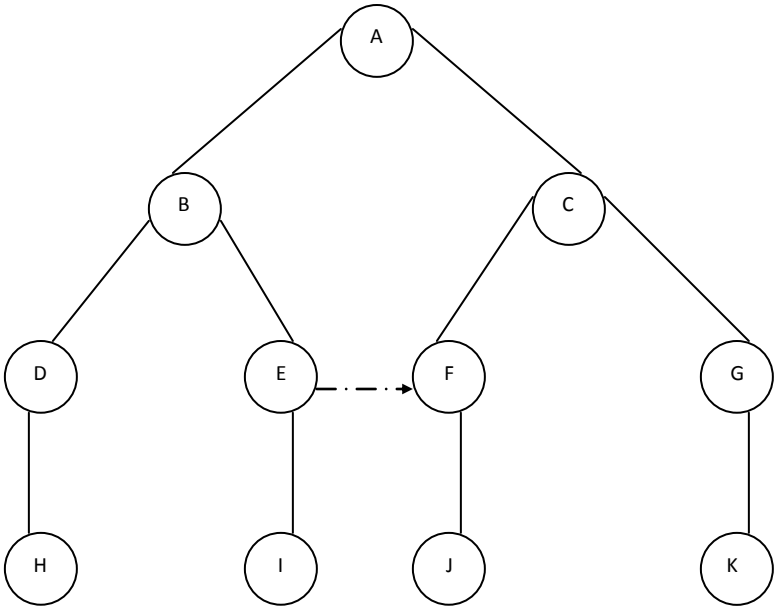

Figure 4: - if the destination is the neighbor

According to this case if the node E is the source and the node F is the destination which is its neighbor then source node checks the location of destination by comparing S(source address) and D(destination address). If D < S, then destination lies on the left side otherwise if D>S, destination lies on the right side. Since for the above example D>S destination lies on the right side of the source node.

Case4: Destination is its neighbor's descendent or parent:- The source node checks if the destination address is one of its neighbor's descendents. If yes, it will transmit the packet to the neighbor. Then the neighbor will find the destination among its descendents.

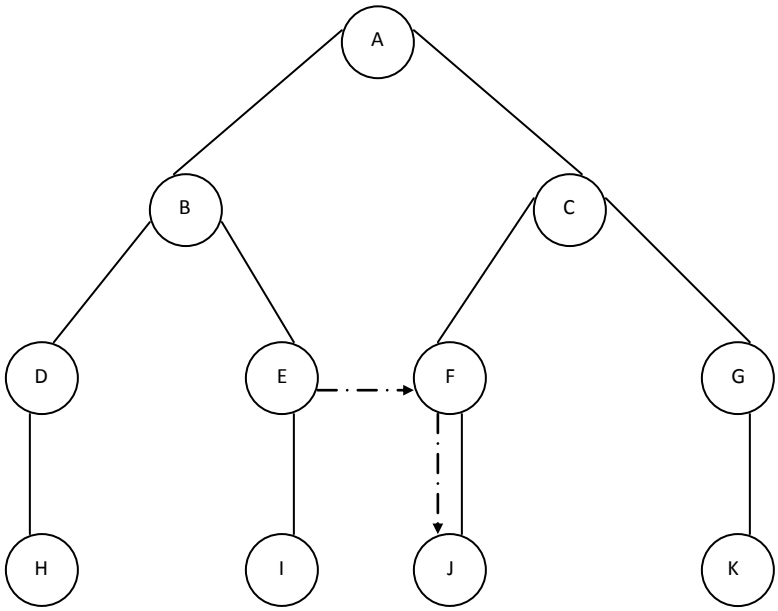

Figure 5: if the destination is the neighbor's descendent

According to the above example node E is the source and the node J is the destination then it will transmit the packet to its neighbor descendent and stop. If the destination is not found then check the neighbor's parent up to the coordinator until the destination is found.

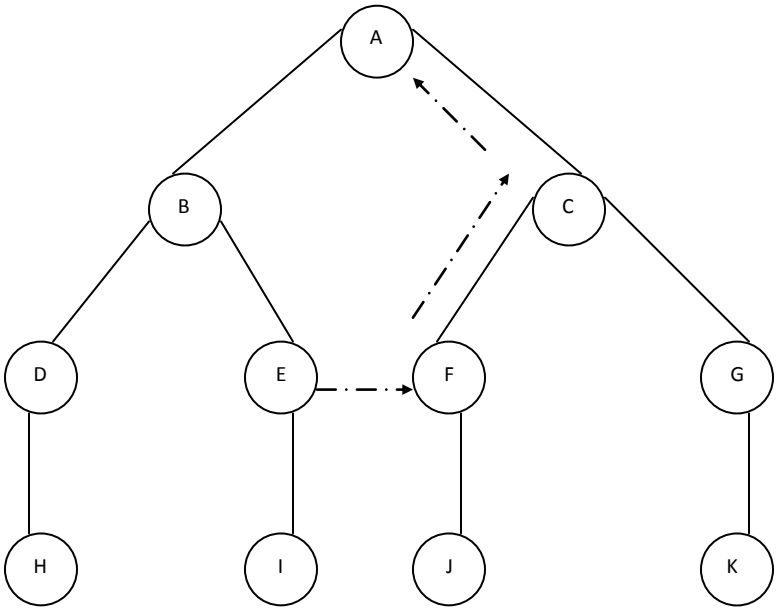

Figure 6 : if the parent of the neighbor is the destination

According to this example node E is our source and the node F is the neighbor node and the node J is the descendent of the neighbor node is not the destination then it will send the packet to its neighbor's parent up to the coordinator until the destination is found.

4.5 Comparison between traditional and Enhanced tree routing algorithms

In a traditional approach, the packet always follow tree topology or parent/child relationship for forwarding the data to the destination node even if the destination node is located nearby. The main benefit of this algorithm is its simplicity and limited use of resources. For example in this network when the node senses data from the environment and want to send it to the destination, it first checks if the destination address is in the address space of the node. If destination node is located in a descendent subtree it sends the packet to the descendent, otherwise it sends packet to ancestor if destination node is located in an ancestor subtree. Tree routing protocol also has an ability to find the next hop node for a given destination address without using routing tables. However, the sender node cannot know if the destination is located nearby or if it's not in the sub-tree which the sender is contained in, since tree routing concerns only about the parent and descendants of the sender node. The tree routing algorithm is efficient in view point of memory usage but sometime the routing cost inefficient.

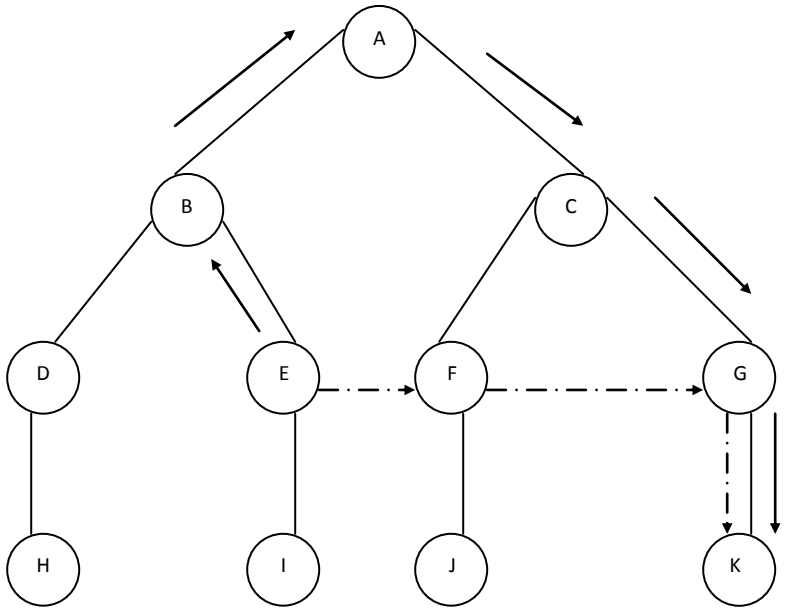

Figure 7: - Problem in tree routing

In the above example the solid lines shows the parent/child relationship. In the tree routing algorithm we can ignore the neighbor's relationship. The dotted lines show the neighbor's relationship which cannot use in this algorithm so, dotted lines show the problem of this algorithm.

The Enhanced Tree Routing algorithm basically follows ZigBee tree routing algorithm, it chooses neighbor nodes as next hop nodes if the routing cost to the destination can be reduced. The neighbor table that we use in this algorithm is defined in the ZigBee specification, so we don't need to make an effort to search neighbor list.

In order to choose the next hop node that can reduce the routing cost, the remaining hop count from next hop node to the destination is computed for all the neighbor nodes including parent and children nodes. In this the route cost can be minimized if the sender transmits the data directly to the destination.

5. CONCLUSION

ZigBee network really helps in improving routing strategy in any network. Due to its several advantages, it has many application areas from home control to industrial automation. Now a day, the objective of any network is to reduce the cost of sending packets from source to destination. Since ZigBee network is using a technique by virtue of which source can send packet to destination directly using neighbor table. So this network really helps to reduce the cost of sending packets to the destination though there are some limitations of this network like low transmission range, low data rate that restrict its use in some applications.

6. FUTURE DIRECTIONS

Networks are growing up every day and getting more and more complex. Routing is the main concern in any network. ZigBee network helps to reduce the routing cost by directly sending the packets to the destination. Despite its advantage, it has some limitation which need to be addressed like low transmission range and low data rate. Research can be done in this direction to improve its transmission range and to increase its data rate.

7. BIBLIOGRAPHY

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