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LIFETIME EXPANSION OF WIRELESS SENSOR NETWORKING SYSTEM USING MODERN ROUTING ALGORITHM

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ABSTRACT

Recent advances in wireless communication and have led to the development of small and low cost sensor devices. The aim of this research is to reduce the consumption of energy and to increase the life of networking system through modern proficient algorithms. A wireless sensor network consists of a large number of sensors distributed over a geographical area with their locations randomly deployed. These sensors comprise of sensing, data processing and communication components. They sense the environment within their respective ranges and communicate the data among themselves over a wireless medium and usually employing a multi-hop approach. The existing traditional methods were studied and interpret the information's for identifying the gaps for improving the life time of networks. Introducing new algorithms of modern routing which is completely controlled by base-station algorithm and optimal sensing ranges algorithm, the network life time has been increased. The data was collected at sinks or base-stations, which have abundant memory, energy and computational capabilities, in contrast to the low-end sensor nodes. Energy consumption is the most important factor to determine the life of a sensor network. Sensor nodes are driven by a battery and have very low energy resources. This makes energy optimization more complicated in sensor networks because it involves reduction in energy consumption and prolong the network life.

Keywords: Wireless Sensor Network, Life Time, Modern Routing Algorithm, Energy

1. INTRODUCTION

Wireless Sensor Network (WSN) consists of randomly/manually deployed sensors that sense the physical or environmental events and send the collected data to the base station. A large number of inexpensive, small and autonomous sensors are generally deployed in an ad hoc manner at remote areas. The routing protocols in WSN aim at reducing the energy consumption and thus prolong the network lifetime. The development of multifunctional low cost and power, sensors is the need of today. Sensor nodes are smaller in size and capable of sensing the events, collecting data and processing it. They also communicate with other sensors in the network, via Radio Frequency (RF) channel. The application areas of WSNs are in the field of civil, health, military and environment. Energy Efficient Routing in Wireless sensor networks has gained a lot of attraction from the researchers in the recent years. To increase the lifetime of the network is a critical and challenging issue and thus it is the routing in WSNs, which is the primary focus of design for researchers. In this paper the modern proficient algorithm such as Optimal Sensing Ranges (OSR) algorithm and an energy efficient Multiple Tree Construction (MTC) algorithm and Low-Energy Adaptive Clustering Hierarchy - Completely Controlled by Base-station are combined to find an optimal energy efficient route for the sensor nodes towards the objective function of the proposed method considers not only the distance of the nodes form the sink but also the lifetime of the network as a function of the maximum energy dissipated by a node in the route [1-3]. It is evident from the simulation results that the performance of the new scheme is improved further over the existing routing protocols. We have achieved optimization of energy through (i) Network coverage i.e., how well a sensor network monitors its region of interest (ii) Optimal deployment of multiple base stations to overcome bottleneck in single base station and clustering scheme that is completely controlled by the base station (iii) The problem of transmitting a packet from one node to another node over a point to point link within a given time is the primary objective of optimal scheduling (iv) Solving dead end problem that results in high packet delivery ratio to the base station (v) Impact of mobility models on performance of routing protocol with respect to packet delivery ratio, latency and throughput in wireless sensor networks [4, 5].Various previous research works related to improvement on the lifetime of wireless sensor networks through different scheduling algorithms and for sensors using data aggregation techniques. Routing with data aggregation targets at jointly exploring the data structure and network topology to reduce energy consumption for data gathering in resource limited sensor networks [6, 7]. Optimization of network lifetime provides information about the life of all nodes in a network and how long it can operate, but it particularly won't indicates a group of routing features as problem limitations. In reality for an estimated lifetime, there are many existing multiple routing alternatives [8, 9]. Due to the large number of nodes in wireless sensor network and the environment complication, in many cases it is very complicated and even impossible to alter or recharge the existing batteries for the sensor nodes [10, 11]. LEACH is the most accepted hierarchical routing algorithms for wireless sensor networks. The main idea in this is to create clusters of the sensor nodes based on the received signal strength and use local cluster heads as routers to the sink which will save the energy consumption because the transmissions will be carried out only by such cluster heads rather than all sensor nodes. LEACH it is not valid to networks installed in large areas because it uses single-hop routing where each node can transmit directly to the cluster-head and the sink [12]. Energy-LEACH algorithm has been introduced for the concept of the energy doorsill and a factor of distance for selecting the cluster head. The energy doorsill is used to establish whether the node could be used as a precondition of the cluster head node, where as to select the smallest data transmission distance path the distance factor is used [13, 14]. The enhanced and unbiased leach protocol is an extension of the LEACH, which develops the steady region of the clustering hierarchy and minimizes the failure nodes probability using heterogeneity characteristic parameters. LEACH and IDA- algorithm with obtainable Fuzzy logic algorithms were compared and the results stated that delay could be condensed from main sources to destinations when compared to existing data packets [15-17]. In several cases, wireless sensor network life time is getting over as soon as the battery power in critical nodes is exhausted. Hence designers and developers of protocols and applications for WSN the main important factor is the availability of power, because life of the battery is considered as the total network life in sensor networks [18-20].

2. WIRELESS SENSOR NETWORK ARCHITECTURE

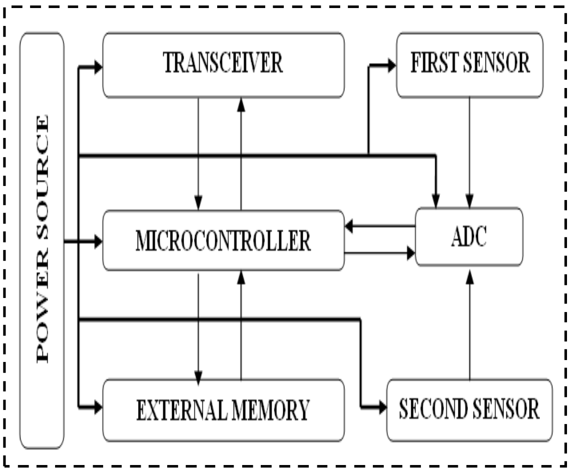

Figure 1 Schematic diagram of network architecture

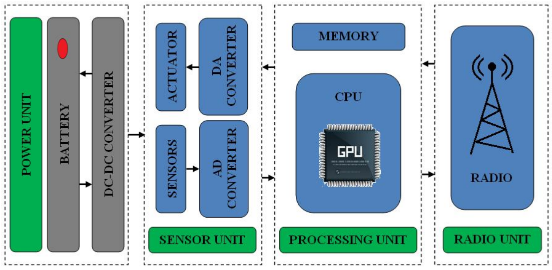

Figure 2 Schematic diagram of sensor node

2.1 Layered Architecture of Wireless Sensor

Wireless sensor networks are emerging as one of the newest forms of wireless networks. The block diagram of network architecture is shown in figure 1. In WSNs, sensor nodes accumulate human physiological data and transmit it to the sink node which is shown in figure 2. However, transmission of physiological data to the sink node over a mobile route becomes a very difficult task for sensors due to their limited battery power. Moreover, substitution of critical sensor nodes is a major challenge in such scenarios. In order to increase network lifetime, some routing protocols have been proposed in the literature, but the majority of them are focused on coverage distance and unconsumed energy of sensor nodes. In this work, we will propose an energy efficient routing algorithm for WSNs. The proposed algorithm will result in enhancement of working lifetime of the network via less energy consumption in comparison to existing routing protocols.

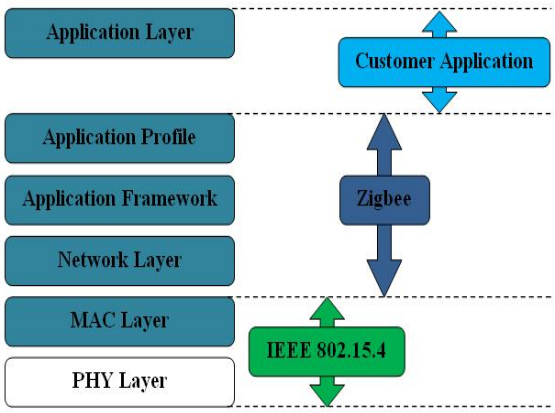

Figure 3 Layered architecture of wireless sensor

3. OPEN SYSTEMS INTERCONNECTION (OSI) MODEL

The Open Systems Interconnection (OSI) model defines a networking framework to implement protocols in layers, with control passed from one layer to the next. It is primarily used today as a teaching tool. It conceptually divides computer network architecture into 7 layers in a logical progression which is shown in figure 3. The lower layers deal with electrical signals, chunks of binary data, and routing of these data across networks. Higher levels cover network requests and responses, representation of data, and network protocols as seen from a user's point of view. The OSI model was originally conceived as a standard architecture for building network systems and indeed, many popular network technologies today reflect the layered design of OSI.

3.1 Physical Layer

At Layer 1, the Physical layer of the OSI model is responsible for ultimate transmission of digital data bits from the Physical layer of the sending (source) device over network communications media to the Physical layer of the receiving (destination) device. Examples of Layer 1 technologies include Ethernet cables and Token Ring networks. Additionally, hubs and other repeaters are standard network devices that function at the Physical layer, as are cable connectors. At the Physical layer, data are transmitted using the type of signaling supported by the physical medium: electric voltages, radio frequencies, or pulses of infrared or ordinary light.

3.2 Data Link Layer

When obtaining data from the Physical layer, the Data Link layer checks for physical transmission errors and packages bits into data "frames". The Data Link layer also manages physical addressing schemes such as MAC addresses for Ethernet networks, controlling access of any various network devices to the physical medium. Because the Data Link layer is the single most complex layer in the OSI model, it is often divided into two parts, the "Media Access Control" sub layer and the "Logical Link Control" sub layer.

3.3 Network Layer

The Network layer adds the concept of routing above the Data Link layer. When data arrives at the Network layer, the source and destination addresses contained inside each frame are examined to determine if the data has reached its final destination. If the data has reached the final destination, this Layer 3 formats the data into packets delivered up to the Transport layer. Otherwise, the Network layer updates the destination address and pushes the frame back down to the lower layers. To support routing, the Network layer maintains logical addresses such as IP addresses for devices on the network. The Network layer also manages the mapping between these logical addresses and physical addresses. In IP networking, this mapping is accomplished through the Address Resolution Protocol (ARP).

3.4 Transport Layer

The Transport Layer delivers data across network connections. TCP is the most common example of a Transport Layer 4 network protocol. Different transport protocols may support a range of optional capabilities including error recovery, flow control, and support for re-transmission.

3.5 Application Layer

The Application layer supplies network services to end-user applications. Network services are typically protocols that work with user's data. For example, in a Web browser application, the Application layer protocol HTTP packages the data needed to send and receive Web page content. This Layer 7 provides data to (and obtains data from) the Presentation layer.

4. EXISTING PROTOCOLS

4.1 Energy Aware Routing

Many energy concerned approach have been proposed towards efficient for wireless sensor networks. The following figure 4 shows the routing protocol for least energy consumption and perfect way for data transmission.
NODE M- Source node (Produce sensory data)
AE- Available energy
Where,
α_i denotes the energy required to transmit the data packet generated by the node M over link
i denotes the node from M to sink

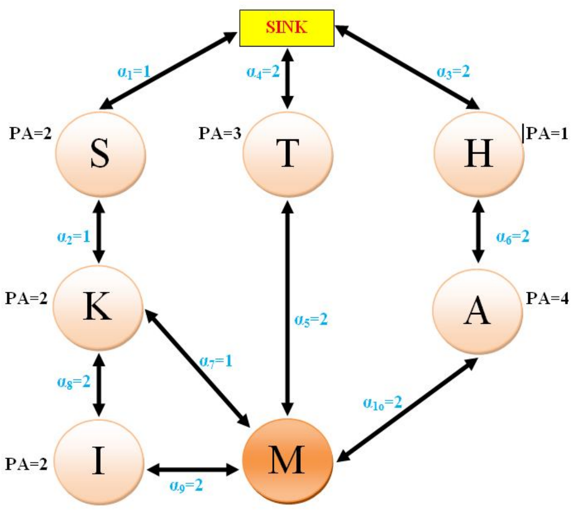

Figure 4 Routing protocol for least energy consumption and perfect way for data transmission

Table 1: Margin specifications

ROUTE	INFORMATION OF PATH
ROUTE 1	SINK-S-K-M Total α=3 Min AE=2 Total AE=4
ROUTE 2	SINK –S-K-I-M Total A=6 Min AE=2 Total AE=6
ROUTE 3	SINK –T-M Total A=4 Min AE=3 Total AE=3
ROUTE 4	SINK –H-A-M Total A=6 Min AE=1 Total AE=5

There are four possible paths and corresponding matrices which are given in table 1.In this simulation route 3 is the perfect way to transmit the information to sink node from child node with minimum available energy. Spatial deployment and data transmission in WSN is illustrated in the following figure 5.

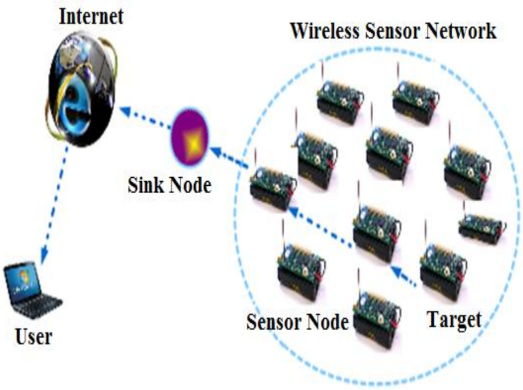

Figure 5 Spatial deployment and data transmission in WSN

4.2 Minimum Total Energy Routing Protocols (MTE)

Initially energy aware routing intended on obtain minimum energy path from source node to sink node.MTE reduces the total energy utilized along the route,
We represent the energy consumed when transmitting packets between n_i and n_j as $P(n_i, n_j)$.

Thus the whole route required energy

$$P_1 = \sum_{i=0}^{D-1} P(n_i, n_{i+1}) \dots \dots$$

$n_{o\ \text{and}}\ n_D$ are source and destination

So, the objective of the scheme is diagnosing the path/route with minimum energy utilization when packets are transmitted.

$$P_0 = \min_{i \in S} P_1$$

Where, **S** is the set of all feasible routes between the source and destination.

4.3 Energy Aware MAC Protocol for Wireless Sensor Networks

The main aim of sink node is to collect and forward the sampled information about the environment, normally a sensor initiate data only when there is an unprecedented event with long idle periods between when no data are collected. But during the transmission of the data from the unusual event, a particular sensor node can initiate extraordinary data traffic. To reduce redundancy and network congestion the traffic is accumulated with the group of sensors called clusters. In which the sensor node act as cluster head (CH) So that normally cluster topology used here.

4.4 Block Diagram of Cluster Topology

A large amount of data is typically forwarded through the entire sensor network through cluster head (CH) towards Base station (BS). Sensor nodes are energy constrained because they run on batteries. Hence it is advantageous to conserve energy even with long idle periods between transmissions. Hence an immense level of energy can be turning off RF (Radio frequency) circuit during the idle periods Rigorous work in this area has been done for asynchronous protocols like PAMAS (Power aware multi access) and MAC (Medium access control) protocols saves energy by periodically saving energy in sleeping mode .But they still require node to listen to the radio channel for a notable amount of time and energy conservation is moderate. The block diagram of cluster topology is shown in the following figure 6.

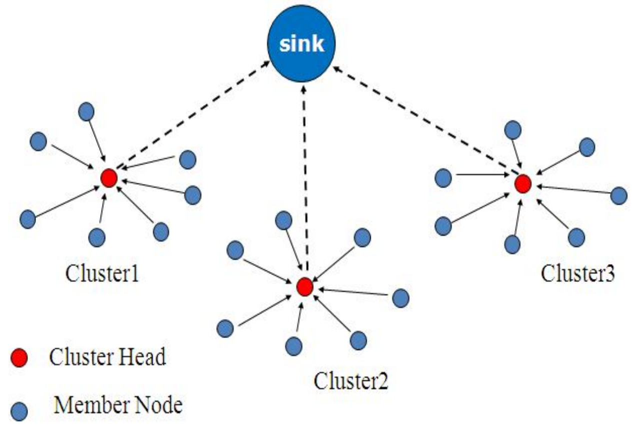

Figure 6 Block diagram of cluster topology

4.5 Proposed Work

Network working lifetime is a tiresome task due to the low energy and to make such networks energy efficient, routing protocol is chosen very carefully. Such routing algorithm is proposed in this paper. This section presents the proposed routing algorithm in which data of all nodes are transmitted to the destination. The destination node is presumed to be enhanced with energy and doesn't t have energy limitation. To transmit data to the destination node this algorithm implements the most achievable routing approach depending upon the location and the residual energy information about each node. This algorithm has considered the communication count and node criticality along with the remaining energy and the coverage distance parameters for routing in WSN. These two additional parameters will help in gaining maximum network lifetime among existing algorithms and will minimize energy consumption in the WSN. Considerations based on which algorithm is proposed are defined in the **set up phase**. The functionality and operations of the algorithm are defined in the **operational phase**.

4.5.1 Setup phase

The proposed algorithm is based on the following considerations:

1) Two types of nodes, namely data nodes and audio nodes are used.

2) Type variable is defined for every node which denotes criticality of a node. It can have two values either info or Audio. If Type has info value, then the node has low criticality and if the value is Audio then the node is highly critical. Node with Type value as Audio is not selected as the next hop for other node's data transmission.

3) Communication count defines how many nodes' data can be forwarded by a single node. It is denoted by the variable CommTotal. A threshold is defined which sets an upper limit for the CommTotal variable.

4.5.2 Operational phase

At the starting, all sensor nodes are deployed in fixed area in WSN. One among them is selected as the destination node to which data of all other nodes, accumulated by sensing within their coverage closeness are transmitted. Nodes within coverage range of the destination transmit data using the single hop transmission technique. However, nodes which transmit outside the coverage range of the destination node adopt multi hop transmission technique.

In case of multi hop transmission, data from the source node to the destination node are transmitted via multiple next hops. To select a next hop, adjacent list of the present node is generated. The neighbor list provides the names of all nodes within the coverage range of the current node. One node among the nodes of the neighbor list is selected as next hop. The next hop selection is performed in two steps.

Step 1: The space of next hop to the destination node must be lower than the current node's distance to the destination node. In addition to this, the energy level of the next hop must be greater than the portal value.

Step 2: After step 1 conditions are fulfilled, four parameters namely remaining energy of a node, coverage distance, communication total and node criticality are examined. When all these conditions are satisfied, then this node is set as next hop and is added to the path from source sensor node to the destination is reached. However, if no such node is found, then in step two is performed for parameters excluding CommTotal parameter. If an appropriate node is found, then it is set as the next hop, but if no such node is found, then step two is repeated for parameters excluding the residual energy parameter. This node is set as the next hop. Now, the energy value of this next hop is updated. Data aggregation process in deployed wireless sensor network is shown in figure 7 where, sensor nodes only need to transmit packets that contain distribution parameters instead of individual values.

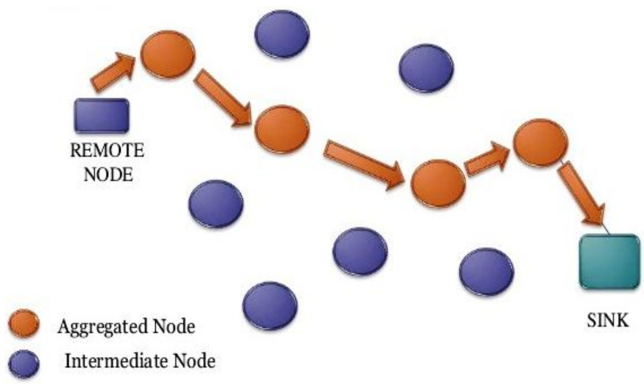

Figure 7 Data aggregation process in deployed wireless sensor network

The pseudo code for the proposed algorithm is as follows:

```
Algorithm (N, Src, Dst)
/* Specify a Network with N Nodes with Source and
Destination*/
  1. For m=1 to N [Define N nodes with the location and
Energy Specification]
{ 2. Nodes(m). location=AreaLoc(A,B)
  Nodes(m). Type = (Info or Audio)
  Nodes(m). Energy=1J
  Nodes(m). CommTotal=0;
}
  3. Set PreNode=Src  [Set Source Node as Present Node]
  4. While PreNode! =Dst [Repeat Process Till Destination
Node does not Occur]
{ 5. Generate the adjacent List for PreNode called
AdjacList
  6. Set nexthop = AdjacList (1)
  7. For i=1 to AdjacList. Length
{ 8. If (Nodes(i).Energy>EThreshold And Distance(i,
Dest)<Distance(PreNode, Dest))
  9.
{ {
  10. Set nexthop=i;
}
  11. Else If (AdjacList (m). Energy>Nodes (nexthop).
Energy and AdjacList (m). Type=Data and AdjacList (m).
  Distance<Sensing Range)
{ 12. Set nexthop =m;
}
  13. Else If (AdjacList (m). CommTotal<Threshold and
AdjacList (m).Type=Data and AdjacList (m).
  Distance<Sensing Range)
{ 14. Set nexthop =m;
} }
15.
}
  16. Nodes (nexthop). Energy= Nodes (nexthop). Energy-
ForwardingEnergy;
  17. Path. Add (next hop)
  18. Nodes (nexthop). CommTotal= Nodes (nexthop).
CommTotal+1
  19. Set PreNode= nexthop
} }
  20. Nodes (Src). Energy= Nodes (Src). Energy-
```

Transmission Energy;
21. Nodes (Dst). Energy= Nodes (Dst). Energy-Receiving Energy;

The energy merit of the next hop is updated after every transmission. The value of CommTotal variable is incremented by 1 after every transmission of the next hop. Now, this next hop node is set as the Present node and this protocol is repeated till the destination node is reached. Finally, when the destination node is reached, energy values of the source node and the destination node are updated.

5. CONCLUSIONS

This paper has presented an algorithm which will perform routing more effectively than existing routing protocols in wireless sensor networks with limited energy nodes. In this proposed algorithm four attributes such as coverage distance, residual energy, communication count and node criticality are taken into account for energy efficient routing in WSN. Node present and communication count parameters highlight on reducing the burden on highly critical nodes and try to balance energy consumption evenly on all the nodes. This would be largely lower the energy consumption and enhance the lifetime of the network. The proposed algorithm appears to be a novel algorithm among the existing algorithms. However, in future some other critical parameters will be considered to optimize the routing in WSN. The work is presented as a framework, in future it can be implemented in other applications.

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