Fuzzy Logic-Based Candidate Selection Routing Algorithm For Lifetime Enhancement In Heterogeneous

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Abstract

Energy harvesting (EH) is considered the key enabling technology for mass deployment of WSN nodes . Efficient EH techniques eliminate the needs for frequent energy source replacement, thus offering a near perpetual network operating environment. Advances in the EH techniques have shifted the design paradigm of routing protocols for energy-harvesting wireless sensor network from "energy-aware" to "energy-harvesting-aware". This work aims to design an Loose virtual clustering combined ANN (artificial neural network) trained energy-harvesting-aware routing protocol for heterogeneous networks in the presence of ambient energy sources. We propose a new routing algorithm , which is further enhanced by integrating a new parameter called "energy back-off". Combining with ANN training , the proposed algorithm improves the lifetime of the nodes and the network's quality-of-service (QoS) under variable traffic load and energy availability conditions. This work also investigates the system performance metrics for different energy harvesting conditions. Performance results demonstrate that the proposed algorithm significantly improves energy efficiency while satisfying the QoS requirements of distributed networks in comparison with existing routing protocols.

I. INTRODUCTION

Routing is the act of moving information from a source to a destination in an internetwork. During this process, at least one intermediate node within the internetwork is encountered.

This concept is not new to computer science since routing was used in the networks in early 1970's. But this concept has achieved popularity from the mid-1980's. The major reason for this is because the earlier networks were very simple and homogeneous environments; but, now high end and large scale internetworking has become popular with the latest advancements in the networks and telecommunication technology.

The routing concept basically involves, two activities: firstly, determining optimal routing paths and secondly, transferring the information groups (called packets) through an internetwork. The later concept is called as packet switching which is straight forward, and the path determination could be very complex. Routing protocols use several metrics to calculate the best path for routing the packets to its destination. These metrics are a standard measurement that could be number of hops, which is used by the routing algorithm to determine the optimal path for the packet to its destination. The process of path determination is that, routing algorithms initialize and maintain routing tables, which contain the total route information for the packet. This route information varies from one routing algorithm to another.

Routing tables are filled with a variety of information which is generated by the routing algorithms. Most common entries in the routing table are ip-address prefix and the next hop. Routing table's Destination/next hop associations tell the router that a particular destination can be reached optimally by sending the packet to a router representing the "next hop" on its way to the final destination and ip-address prefix specifies a set of destinations for which the routing entry is valid for.

A. Classification of Dynamic Routing Protocols

Dynamic routing protocols are classified depending on what the routers tell each other and how they use the information to form their routing tables. They are Distance vector protocols and Link state protocols Most of the protocols available in the networks fit into one of the two categories.

B. Distance Vector Protocols

By using the distance vector protocols, each router over the internetwork send the neighboring routers, the information about destination that it knows how to reach. Moreover to say the routers sends two pieces of information first, the router tells, how far it thinks the destination is and secondly, it tells in what direction (vector) to use to get to the destination. When the router receives the information from the others, it could then develop a table of destination addresses, distances and associated neighboring routers, and from this table then select the shortest route to the destination. Using a distance vector protocol, the router simply forwards the packet to the neighboring host (or destination) with the available shortest path in the routing table and assumes that the receiving router will know how to forward the packet beyond that point. The best example for this is the routing information protocol (RIP).

C. Link-State Protocols

In link state protocols, a router doesn't provide the information about the destination instead it provides the information about the topology of the network. This usually consist of the network segments and links that are attached to that particular router along with the state of the link i.e., whether the link is in active state or the inactive state. This information is flooded throughout the network and then every router in the network then builds its own picture of the current state of all the links in the network.

D. Mobile Ad-hoc Networks

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self configuringmultihop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multihop forwarding. The nodes in the network not only acts as hosts but also as routers that route data to/from other nodes in network.

In mobile ad-hoc networks where there is no infrastructure support as is the case with wireless networks, and since a destination node might be out of range of a source node transmitting packets; a routing procedure is always needed to find a path so as to forward the packets appropriately between the source and the destination. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of ad-hoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes.

Problems with routing in Mobile Ad-hoc Networks

– Asymmetric links: Most of the wired networks rely on the symmetric links which are always fixed. But this is not a case with ad-hoc networks as the nodes are mobile and constantly changing their position within network. For example consider a MANET(Mobile Ad-hoc Network) where node B sends a signal to node A but this does not tell anything about the quality of the connection in the reverse direction.

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II. REALTED WORK

Gang Shen et al provides throughput enhancement, especially at the cell edge. This paper first reviews the key technical advances with multi-hop relay in cellular networks. Then, novel technical solutions and algorithms for multi-hop relay are introduced and analyzed, including the separation of control and data,effective signal-to-interference-plus noise ratio (SINR)-based routingalgorithms, and cooperative relay schemes.

Milos stojmenovicand venkatnarasimhan proposes a novel trust management scheme for improvingrouting reliability in wireless ad hoc networks. It is grounded on two classicautoregression models, namely Autoregressive (AR) model and Autoregressivewith exogenous inputs (ARX) model. According to this scheme, anode periodically measures the packet forwarding ratio of its every neighboras the trust observation about that neighbor.

Chao-Chin Chou et al proposes an Efficient Anonymous CommunicationProtocol for Peer-to-Peer Applications overMobile Ad-hoc Networks.

AishwaryaSagarAnandUkey et al proposed that deals with such routing misbehavior and consists of detection and isolation of misbehaving nodes. Proposed approach can be integrated on top of any source routing protocoland based on sending acknowledgement packets and countingthe number of data packets of active path.

Mohamed et proposes An Integrated Stimulation and PunishmentMechanism for Thwarting Packet Dropping Attack in Multihop Wireless Networks

Mohamed Elsalih Mahmoud et al proposes Secure Incentive Protocol withLimited Use of Public-Key Cryptography for MultihopWireless Networks.

Pedro B. Velloso et al proposesa human-based modelwhich builds a trust relationship between nodes in an ad hocnetwork. The trust is based on previous individual experiencesand on the recommendations of others.

Yong Li, Guolong et al present he Impact of Node Selfishness on Multicasting in Delay Tolerant Networks. Due to the uncertainty of transmission opportunitiesbetween mobile nodes, delay tolerant networks (DTNs) exploitthe opportunistic forwarding mechanism.

III. EXISTING SCHEME

WSN ROUTING PRINCIPLES

Routing protocols which researchers have developed to meet the challenges of WSN routing, many of which feature different methods of managing the issues associated with mobility. The two survey papers both find that every protocol identified also fit into the core categories of; reactive, proactive or hybrid routing protocols in additional to any other characteristics they exhibit.

A. Proactive Routing

Proactive protocols rely upon maintaining routing tables of known destinations, this reduces the amount of control traffic overhead that proactive routing generates because packets are forwarded immediately using known routes, however routing tables must be kept up-to-date; this uses memory and nodes periodically send update messages to neighbours, even when no traffic is present, wasting bandwidth. Proactive routing is unsuitable for highly dynamic networks because routing tables must be updated with each topology change, this leads to increased control message overheads which can degrade network performance at high loads.

B. Reactive Routing

Reactive Protocols use a route discovery process to flood the network with route query requests when a packet needs to be routed using source routing or distance vector routing. Source routing uses data packet headers containing routing information meaning nodes don't need routing tables; however this has high network overhead. Distance vector routing uses next hop and destination addresses to route packets, this requires nodes to store active routes information until no longer required or an active route timeout occurs, this prevents stale routes . Flooding is a reliable method of disseminating information over the network, however it uses bandwidth and creates network overhead, reactive routing broadcasts routing requests whenever a packet needs routing, this can cause delays in packet transmission as routes are calculated, but features very little control traffic overhead and has typically lower memory usage than proactive alternatives, this increases the scalability of the protocol .

C. Hybrid Routing

Hybrid protocols combine features from both reactive and proactive routing protocols, typically attempting to exploit the reduced control traffic overhead from proactive systems whilst reducing the route discovery delays of reactive systems by maintaining some form of routing table . Survey papers successfully collect information from a wide range of literature and provide detailed and extensive reference material for attempting to deploy a WSN, both papers reach the conclusion that no single WSN routing protocol is best for every situation meaning analysis of the network and environmental requirements is essential for selecting an effective protocol. Whilst these papers contain functionality details for many of the protocols available, performance information for the different protocols is very limited and no details of any testing methodologies is provided, because of this the validity of some claims made cannot be verified.

IV. EARLY WSN ROUTING PROTOCOLS

The next piece of literature is a protocol performance comparison by which compares the proactive Destination Sequenced Distance Vector (DSDV) protocol and the reactive Dynamic Source Routing (DSR) protocol; these protocols were developed in 1994 and were amongst the earliest MANET routing protocols identified using the previous survey papers.

A. Destination Sequenced Distance Vector (DSDV)

The proactive DSDV protocol was proposed by and is based upon the Bellman-Ford algorithm to calculate the shortest number of hops to the destination . Each DSDV node maintains a routing table which stores; destinations, next hop addresses and number of hops as well as sequence numbers; routing table updates are sent periodically as incremental dumps limited to a size of 1 packet containing only new information . DSDV compensates for mobility using sequence numbers and routing table updates, if a route update with a higher sequence number is received it will replace the existing route thereby reducing the chance of routing loops, when a major topology change is detected a full routing table dump will be performed, this can add significant overhead to the network in dynamic scenarios ..**Dynamic Source Routing (DSR)**

The reactive DSR Protocol is broken into two stages; route discovery phase and route maintenance phase, these phases are triggered on demand when a packet needs routing. Route discovery phase floods the network with route requests if a suitable route is not available in the route . DSR uses a source routing strategy to generate a complete route to the destination, this will then be stored temporarily in nodes route cache . DSR addresses mobility issues through the use of packet acknowledgements; failure to receive an acknowledgement causes packets to be buffered and route error messages to be sent to all upstream nodes. Route error messages trigger the route maintenance phase which removes incorrect routes from the route cache and undertakes a new route discovery phase .

V. PROPOSED SYSTEM

This paper proposes an intelligent routing protocol (IRP) based on artificial neural network (ANN) for wireless sensor networks. IRP performs considers routing cost ,energybackoff and harvesting of node . This process causes less overhead and helps in achieving the real advantage of clustering in wireless sensor networks. Once the cost finding completed, the routing phase comes into action. In the routing phase, the table driven protocol is used to forward the data at the intercluster level and on-demand based protocol is used to forward the data at the intracluster level

VI. ENERGY HARVESTING PROCESS

Considering the battery levels at the given node, we assume thatthe nodes battery can be partitioned into three levels and two regions .Level 3 is the minimum energy level to ensurethat sensor node operates well with four operating modes (i.e.,receiving, transmitting, idle listening and sleeping). We investigatethree following cases:

A. Case 1: Level 2 <Eir< Level 1

The residual energy is sufficiently high for the nodes to maintaintheir normal operations. Hence, the energy harvesting process is notrequired in this circumstance.

B. Case 2: Level 3 <Eir< Level 2

In this case, we exploit the sleeping period to enable nodes toharvest more energy. By doing that, the nodes not only reduce theirenergy consumption, but also harvest a small amount of energy fromambient energy sources. As a result, they can extend their lifetime.

C. Case 3: 0 <Eir< Level 3

In this case, there may not be enough energy for the nodes tomaintain their normal operations. Hence, the node must temporarilyturn off its transceivers and enter the sleeping mode to save energyas well as to wait for recharge until the battery level is recoveredi.e., higher than Level 3). By doing so, the nodes can significantlyreduce their consumed energy and accumulate a small amount ofenergy to prolong their lifetime.

Here, we introduce an energy back-off process whose purposeis to extend the back-off period . By doing this, the node will have more timeto wait and harvest energy from the surrounding energy sources.Because the node needs to wait more time before a transmissionopportunity, the system’s end-to-end (E2E) delay will increase,whilst the system throughput will decrease due to the reduction inthe number of data packets transmitted from the nodes.The “energy back-off” process treats the energy harvesting processesof the nodes powered by the heterogeneous energy sourceswith fairness, thus extending the network lifetime.

VII. INTELLIGEN ROUTING PROTOCOL (IRP)

The proposed intelligent clustering routing scheme is based on artificial neural network. Two issues are addressed by this routing approach. They are clustering and routing. When the source node wants to send data to a destination, and has information about its CH, then the packets are sent to the CH. The

CH takes care of further processing. When the source has no information about the CH, then it initiates the clustering process by sending the cluster formation request. Cluster formation using ANN The cluster formation consists of two steps. The first step uses the 20/80 rule to identify the number of clusters. This process is used in order to reduce the number of clusters to be formed in the network. The second step uses the ANN based method to identify the required clusters and its cluster head. This clustering structure is adopted because monitoring nodes in the entire network cause bigger overhead than watching less number of nodes in the cluster. Cluster identification In this paper, the competitive neural network based algorithm is used for cluster identification when the locations of the node set are non-overlapping. Figure- depicts the overall architecture of this cluster identification module.

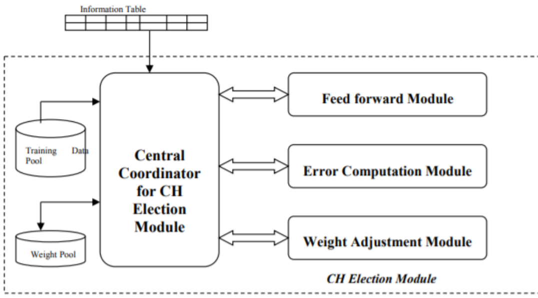
The locations of the various nodes are extracted and provided as an input to the neural network which identifies the clusters in the node set. The algorithm starts the identification process by computing the distance between the input nodes and weight nodes. On the basis of smallest distance value, the winning neuron is decided.

Initialize the structure of the ANN;
Initialize weights w_{c1}, w_{c2} for each cluster c;
Initialize the learning rate constant α ;
Initialize n as number of nodes;
Initialize c as number of clusters;
For each node n do
Obtain location LX_n, LY_n;
For each c do
Compute $D_{nc} = (w_{c1} - LX_n)^2 + (w_{c2} - LY_n)^2$;
End For
The node n which is having its D_{nc} minimum, is assigned to cluster c;
Update the weight of the winning unit
$w_{c1}(new) = w_{c1}(old) + \alpha[LX_n - w_{c1}(old)]$;
$w_{c2}(new) = w_{c2}(old) + \alpha[LY_n - w_{c2}(old)]$;
End For

Figure ANN cluster formation

A. Algorithm for ANN

In this method, the input causes a response to the neurons of the first layer which in turn causes a response to the neurons of the next layer, and so on, until a response is obtained at the output layer. The obtained response is then compared with the target response, and the difference (the error signal) is calculated. From the error difference at output neurons, the algorithm computes the rate at which the error changes, as the activity level of the neuron changes. Here, the algorithm steps back one layer before the output layer and recalculate the weights of the output layer so that the output error is minimized. The algorithm continues by calculating the error and computing new weight values, moving layer by layer backward, toward the input. When the input is reached and the weights do not change, then the algorithm selects the next pair of input-target patterns and the process is repeated. Once the training process is over, the back propagation network is ready for election. Routing Once the clustering is over, the network is ready for communication. The information about the clustering process is broadcasted into the network. The CH in each clusters take care of communication in the network. When a node wants to transfer data to its destination, it sends the packet to the CH, which checks whether the destination is in its cluster. If the destination is found in the cluster, the packet is then transferred to the destination with the help of intracluster routing protocol. This protocol is an ondemand protocol. If the destination is not found in the cluster, then the packet is transferred to the other CH with the help of intercluster routing protocol, which is a tabledriven protocol. The ad-hoc on-demand distance vector protocol and destination sequenced distance vector protocol are modified to implement the proposed routing scheme



VIII. CONCLUSION

In this project, we have proposed a new protocol using ANN.; It incorporates the features of Energy back off calculation ,harvesting and overall routing cost. Moreover, it uses ANN for training the protocol by taking into account the following parameters such as residual energy, distance of node from CH, distance of CH from Chief nod or boarder node, distance of the boarder node to the next Chief node or the BS, traffic load on the particular link, and the probability of health status of the particular path. All these factors make this protocol different from the existing state-ofthe- art protocols, e.g., LEACH, HEED, EEMDC, DDAR, and O-LEACH etc. Therefore, performance evaluations of this protocol show better improvements in energy consumption reduction, delay and throughput .

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