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RESEARCH ARTICLE

Quality of Service Aware Code Dissemination in Wireless Sensor Networks

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ABSTRACT

This paper presents a new method for updating the quality data over the networks through Delay Conscious Code Dissemination protocol (DCD). This protocol has two distinguishing characteristics from the existing protocol strategies. Layering approach is used to architect the sensor nodes to reduce the energy consumption and to extend the lifespan of the broad Wireless Sensor Network (WSN). The entire system has been assessed by using OneSim simulator version one_1.4.1 and the results have been highlighted to distinguish our system with the existing protocol of Efficient Code Dissemination (ECD). It has been found that our system contribute the least possible duration for disseminating the information over the network.

Keywords: DCD, Protocol, Layering approach, WSN, ECD.

1. INTRODUCTION

A wireless sensor network is a group of spatially allocated sensors used for monitoring and recording physical conditions like temperature, pressure, humidity, wind, direction, speed, vibration intensity, illumination intensity, sound intensity, pollutant levels, power line voltage, chemical concentrations, vital body functions at different locations.

[1] presented a detail note on the concept of sensor networks which was made feasible through micro-electro mechanical systems technology, digital electronics and wireless communication. It has been suggested to develop new sensor networks which can overcome restrictions brought out by fault resilience, amount, scalability, surroundings, change of arrangement and power utilization. [2] enumerated the difficulties of Wireless Sensor Networks (WSN), mandatory conditions required for reprogramming and features of existing protocols thus providing guidelines for the clients and minimizing the efforts of the designer. [3, 4] prevailed a brief summary about different types of dissemination protocols used in variety of wireless sensor networks for providing program code, configuring the limits, questions, requests and so on. It has been suggested to develop a safe dissemination protocol due to the inefficiency of the existing ones. [5] demonstrated the utilization of coordinative mutual management for WSN and the design of simple Sensor Network Management System (SNMS) to reduce the effect on storage and amount of information transferred at a time.

[6] explained a novel method known as code drip, a different type of information dissemination protocol for WSN to increase the efficiency, security and speed. Even though this method is faster, it cannot be applied to different bus arrangement and it does not have the ability to combine messages. [7] illustrated a summary on dissemination protocol for finding information in wireless networks based on searching and scanning. However the balance between the searching and scanning forms a hindrance amid the deterministic and randomized algorithm. [8] hypothesised a new protocol to choose the required information. But there is no practical proof for applying this protocol in wide scattered applications which

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are used for data compactness. [9] elucidated a model for reproducing large information from single or multiple sources to single or multiple destinations accomplished by a multi-hop through deluge. But this is a very slow process and very large effort is necessary to improve its efficiency.

[10] discussed the design intension, constraints, options and developments for dissemination and transmitting conditions and also presented a code sharing for Mica-2 motes referred to as Multi-hop Over the Air Programming (MOAP). Still, this entire network has a poor performance and efficiency. [11] brought out an alternative sender algorithm for a multi-hop reprogramming service that had been constructed to reduce the application for RAM. Yet several characteristics such as applying EEROM to provide better reprogramming, avoiding the problems due to the addition of nodes, resisting the idle state have to be addressed. [12, 13] described a protocol for transferring large information safely by the combination of tuned timers, timely retransmission and variations in frequency to reduce disagreement and advance reuse. Still this method cannot be adopted for changing packet size. [14] An Efficient Code Dissemination protocol (ECD) had been developed that has the features to support the changing packet size by employing an exact sender algorithm and timer construction. Even though this approach has better characteristics than already existing ones, it is not efficient for large wireless networks.

[15] provided a mathematical analysis on the accomplishment of largely distributed information on a wireless network using precise propagation way. Still, this approach can be used only for general wireless networks to reduce the completion time and not for complex networks. [16] dealt with the remodelling of the sensor network to reduce the information crash with the help of a sender choice algorithm. Even though this method is energy efficient one, this method uses several algorithms to reduce the energy consumption. [17] explained the need for reprogramming the WSN for the purpose of repair and efficient administration besides analysing the architect considerations. [18] elucidated the usage of Wi-Fi network in the closure estimate of portion of the trees above the land for proper supervision of the forest and to maintain the balance of the ecosystem. However there occurs a failure in the alignment during the addition of nodes.

This paper proposes a new approach to update large information safely on a wireless network in a short duration of time with the help of layering and genetic algorithm.

2. METHODOLOGY

2.1. Delay Conscious Code Dissemination (DCD) protocol

DCD protocol reproduce the source code by giving priority to the linking quality of the nodes and the time required for spreading the information. Link quality of a signal is the probability that a packet transmitted by one node will be profitably acknowledged by the other node if it is a directed node combination. Usually link quality will range from 0 to 100, with 100 as the highest possible value. The minimum value represents no passage of information during the examination phase and the maximum value represents that the data packet is delivered or propagated at the maximum PHY data rate.

When a node gets an entire new cipher it gets converted into a starting point, which can be used to distinguish several paths into a sequence of single path communications.

2.2. DCD protocol design

The block diagram for the design of DCD protocol is depicted in figure 1.

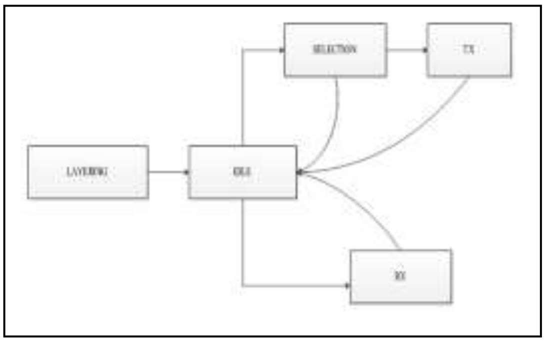

Figure 1.Block diagram of DCD protocol design

The designing of a DCD protocol consists of five individual phases namely

- Layering Phase
- IDLE Phase
- SELECTION Phase
- TX State
- RX State

2.2.1. Layering phase

The transportation of messages in a node is established by the layering approach. Generally layer approach is carried out on large networks, where the layers of the sensor node are situated around the starting node with respect to their distance.

2.2.2. Idle phase

Consider two nodes P and Q. At first, node P will be in the idle state i.e. at ineffective state and it reveals (ADV) the complete details of the pages it has to deliver. When the other node Q catches this ADV message, it sends a request message (REQ) to P to access the pages and converts that node to RX state. The node Q changes to the IDLE state only when it receives all the pages from P or when there is no reception of messages.

2.2.3. Selection phase

Genetic algorithm is used to select the best source node to exhibit the optimal natural selection. The nodes which are suitable for delivering the information passes to the TX state and the other nodes remain in the idle state.

2.2.4. TX state

The eligible nodes transmit information in the TX state. When the sender transmits the code in packet by packet, the receiver stores the packets in Electrically Erasable Programmable Read Only Memory (EEPROM). After delivering the information, the source node resumes back to the idle state.

2.2.5. RX state

A node passes to the RX state in the rear of sending request messages to the supplier node.

2.3. Layering

It is a very tedious process to retrieve information from a wide sensor network as it consumes more time and energy. So in the view of energy management, layered architectural approach has been used for transmitting the information and to increase the life span of the sensor nodes. The transmission efficiency depends upon the distance between the two nodes. Greater the distance, lesser will be the efficiency and vice-versa. Hence the sensor at the high level communicates with the sensor at the low level that are located nearest to them.

Every layer will be arranged with minimal spacing between them, which aids in low consumption of energy during information exchange. Consider n and m to be the number of source node and number of total nodes respectively. S_j denotes the source node that varies from 1 to n and m_i represents the node that varies from 1 to m. The source node forms layers around them based on their hop count to each other node in the network. The layering of two source node and various sensor nodes have been showcased in figure 2.

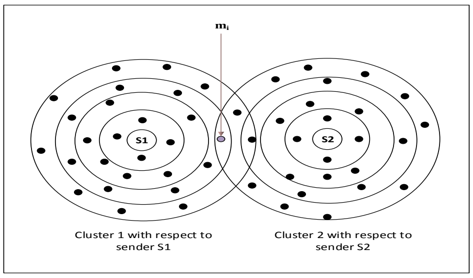

Figure 2.Layering approach

In the above figure, at group one layer 1 is at a one hop distance from the source node, layer 2 is at two hop distance from the source node and so on. Similarly at group two layer 1 is at one hop distance from source node, layer 2 is at two hop distance from the source node and so on. Let the receptor node be m_i. It receives data from source 1 as it is near to it. So the transfer of information takes place only to the nearest possible node.

2.3.1. Algorithm for layering

The program code for layering is as follows

```
        Create n cluster
        For each node mi in m
        Cj=min (L(mi]);
//L[mi] counts the hop of mi with respect to sj
        Add mi to Cj;
        End for
  End
```

2.4. Selection

The selection process is done based on genetic algorithm to produce the best solution.

2.4.1. Chromosome representation

A chromosome is a determined criterion that represents the suggested solution. Every chromosome has a static size depending upon the number of nodes in the network topology. The chromosome can be either represented in binary format or in string format. An example for a network and its chromosomal representation is depicted in figure 3 and table 1.

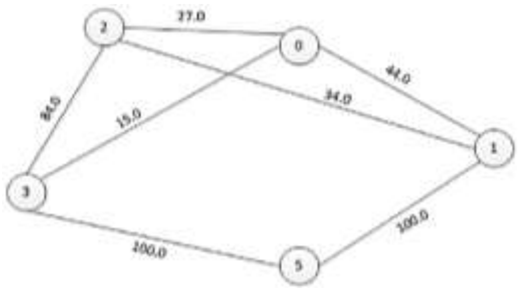

Figure 3.Example for a network

Table 1.Chromosomal representation for figure 3

Gene Index	0	1	2	3
Gene Value	3	5	1,3	5

The gene index denotes the identification number of the node and the gene value represents the identification number of parent of that particular node.

2.4.2. Gene representation

The gene representation of a node refers to the information about the linking quality of a node and the probability of receiving data from the other node. For figure 3 the gene representation for various nodes are given below in table 2 and 3.

Table 2.Gene representation for node 0

Node	Actual	Percentage
3	15.00	1.00

Table 2 indicates the node 0 has a linking quality of 15% with node 3 and it can receive 100% data from node 3. Similarly the gene representation of other nodes is represented in table 3.

Table 3.Gene representation for node 1, 2 and 3

Gene Index	Node	Actual	Percentage
1	5	100.0	1.00
2	1	34.00	0.288135
2	3	84.00	0.711864
3	5	100.00	1.00

2.4.3. Genetic Algorithm (GA)

GA is used to generate best solution for combinatorial problems. GA depends upon the biological operators such as mutation, chromosome, crossover, genes and selection. The different steps followed in GA are

- Initialization
- Selection
- Crossover
- Mutation
- Termination

At the beginning, a population set will be generated randomly covering all the possible solutions depending upon the nature of the problem.

From every generation, a part of the population will be selected and allowed to breed to reproduce different generation. In distinction to new generation, distinctive resolutions will be selected depending upon the fitness function.

During the crossover, the characteristics of chromosome from one generation will be altered for the next generation. Crossover takes two or more parent solution and reproduces a child solution. Merging the results of good individuals will produce better solution. The chosen individuals will be represented as a sequence of binary numbers and for crossover a part of bits will be selected and exchanged to obtain new offspring. There are various crossover techniques such as

- Single point crossover
- Two point crossover
- Cut and slice
- Uniform crossover
- Half uniform crossover
- Three parent crossover

The new generation exhibits the characteristics of the combined parents so that there will be variation in the genetic pattern. The main objective of mutation is to highlight the diversity within the population and to premature convergence.

After reaching a steady number of generations, the process will be halted.

2.4.3.1. Program code for GA

```
X=Initialization ()
  For i=0 to round N
    X=Selection (X);
    X=Crossover (X);
    X=Mutation (X);
    X=Best (X);
  End for
```

```
Initialization ()
  Choose four random sequence of population.

Selection ()
  Input: Sequence [] X
  Output: Sequence [] Y
    Y= list of sequence of length 2N;
      For i=0 to N
        Y [i] = X [i];
      For i=0 to 2N
        Choose two sequence A, B from X;
        C= Sequence with lowest delay in {A, B};
        Y [i] =C;
      End

Crossover ()
  Input: Sequence [] X
  Output: Sequence [] Y
    Y= list of sequence of length 2N;
      For i=0 to N
        Y [i] = X [i];
      For i=0 to 2N
        Choose two sequence A, B from X;
        C= Combine A, B to form C;
        Y [i] = C;
      End

Mutation ()
  Input: Sequence [] X
  Output: Sequence [] Y
    Y= list of sequence of length 2N;
      For i=0 to N
        Y [i] = X [i];
      For i=0 to 2N
        Choose one sequence A from X;
        Perform mutation on A to form C;
        Y [i] = C
      End

Best ()
  Input: Sequence [] X
  Output: Sequence [] Y
    X = List of sequence of length 2N;
    Y = List of sequence of length 2N;
    Sort X based on rank;
    Select the best four of X;
  End
```

2.4.3.2. Rank calculations

Eventually after the completion of the entire process, all the generated sequence by GA will be arranged based on their ranks. In our proposed system the rank of the nodes will be based on the time it takes to transmit information to other nodes. Consider node 5 to be the source node in figure 3. The rank calculation of the nodes will be based upon the dissemination time which is reported in table 4.

Table 4.Rank calculations

Node	Time
5	0.0
1	1.0
3	1.0
2	1.71186440
0	2.0
Total Time	2.0

The source node transmits the information to the nearest two nodes 1 and 3 with the maximum linking quality in unit time. Further the node 3 transmits the same information to the nearest nodes 2 and 0 within a time of 0.71186440 and 1 respectively. So the total time taken by the information to reach node 2 and 0 will be 1.71186440 and 2. Hence the rank of the network will be 2, which is the total time taken by the network.

3. RESULTS AND DISCUSSIONS

The proposed system has been evaluated to determine its performance, without making any assumptions of the network arrangement. The simulation is carried out in ONE simulator (version one_1.4.1), drafted in java so as to create the transition of the nodes. The specifications used for the simulation is given in table 5.

Table 5.Specifications for simulation

S.no	Parameter	Values
01	Number of nodes	50-100
02	Number of senders	1-5
03	Average link quality	0-100
04	Delay	Unit time
05	Transmission range	600 x 600 m
06	Simulation Time	100 seconds

We have considered a network having nodes in the range of 50-100, for a sending capacity of 1-5. The average link quality may range from 0 to 100. The experiment is repeated for five times to determine the performance of the suggested system. A graph showing the delay time versus number of nodes is elucidated in figure 4 for comparing the existing ECD and the proposed DCD.

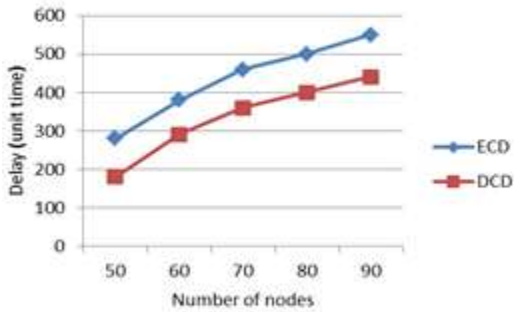

Figure 4.Delay time vs. number of nodes

It can be concluded from the graph that the suggested DCD takes less time to transmit information than the existing ECD protocol.

Similarly a graph is drawn with delay time against the number of senders to compare the performance of the proposed DCD and the existing ECD which is highlighted in figure 5.

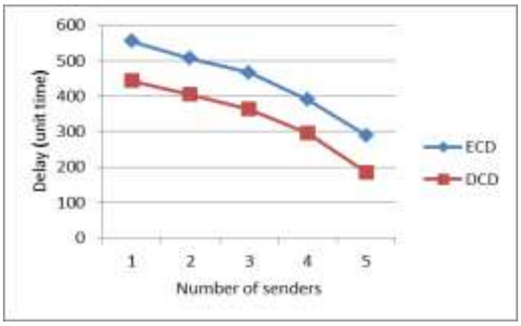

Figure 5.Delay time vs. number of senders

A graph is plotted with average link quality against the number of nodes as in figure 5. From the figure 6 it is evident that the amount of time taken to retrieve the information by the interposed nodes using the DCD protocol is less when compared to the existing ECD protocol.

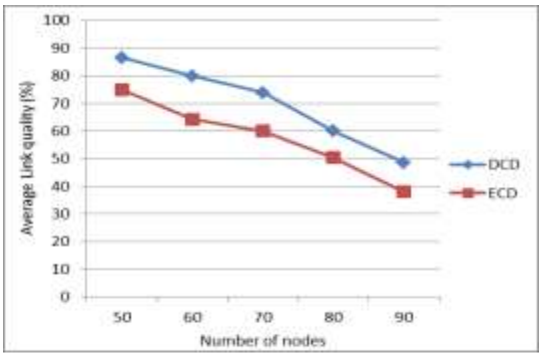

Figure 6.Average link quality vs. number of nodes

Each sender nodes will transmit the information to the other nodes in their respective groups so that the performance of the DCD is better than the existing protocol. The graph displaying the performance variation of the DCD with the existing protocol is plotted with average link quality against the number of sender and is presented in figure 7.

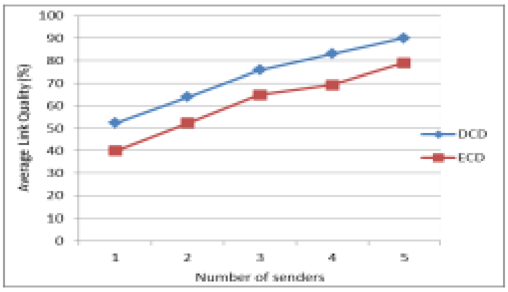

Figure 7.Average link quality vs. number of senders

4. CONCLUSION

In this paper, we have implied a DCD protocol that carry out layering and genetic algorithm for the safe transmission of information. The protocol transmits information to the nearest possible node so that the time required for transmission and retrieval of information is minimized. We have experimentally confined the performance of our system based on the dissemination time and average link quality.

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