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Design an Algorithm Based on Bio Inspired Mechanism for Path Optimization in WSN

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Abstract

In this paper we will design a proposed algorithm that is based on Bio-inspired mechanism for path optimization in wireless sensor network. The basic idea behind this algorithm is based on ant bee colony, to find the shortest path from source to destination.

Keyword: WSN, Genetic Algorithm, Ad-hoc deployment.

1. Introduction

A wireless sensor network (WSN) is a network that is made of hundreds or thousands of these sensor nodes which are densely deployed in an unattended environment with the capabilities of sensing, wireless communications and computations (i.e., collecting and disseminating environmental data). Many different routing, power management and data dissemination protocols have been designed for wireless sensor networks (WSNs), dependent on both the architecture of wireless sensor network (WSN) and the applications that WSN is intended to support. These protocols support the practical existence of WSNs and efficiently make them an integral part of our lives in the real world [1]. A sensor network is composed of a large number of sensor nodes, which are densely deployed in a terrain under monitoring. These sensors have the ability to communicate either among each other or directly to an external base-station. A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Each sensor node comprises sensing, processing, transmission and power units. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed better understand how the software interacts with the other parts of the system, and what needs to be further developed in a systematical way[2]. Security becomes extremely important factor when sensor networks are randomly deployed in a hostile environment. Even through wireless sensor network is an advanced technology of network, it is extremely different from traditional wireless networks. This is, due to the unique characteristics of sensor nodes in WSN. So existing security mechanisms of traditional wireless networks are not directly applied in WSN [3].

1.1 Architecture of Wireless sensor Network

Wireless sensor networks consist of individual nodes that are able to interact with the environment by sensing or controlling physical parameters. These nodes have to collaborate to fulfill their tasks. The nodes are interlinked together and by using wireless links each node is able to communicate and collaborate with each other. As shown in Figure 1, the wireless sensor network comprises of the standard components like sensor nodes (used as source, sink/actuators), gateways, Internet, and satellite link, etc.

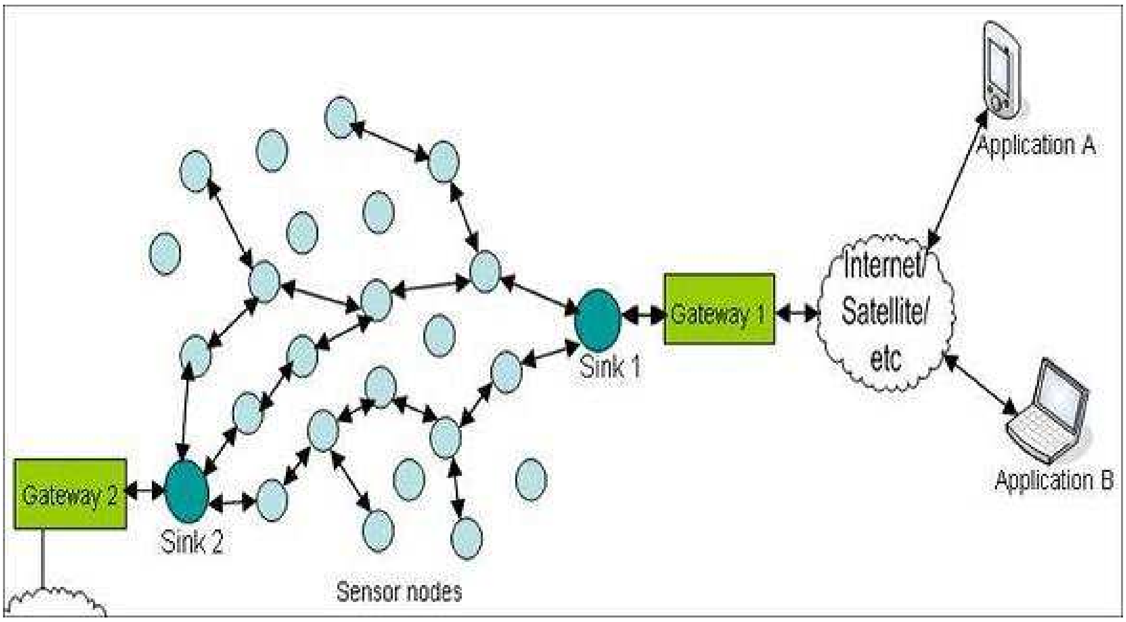

Figure 1: Architecture for Wireless Sensor Networks (WSN).

1.2.1. Sensor nodes

Sensor nodes are the network components that will be sensing and delivering the data. Depending on the routing algorithms used, sensor nodes will initiate transmission according to measures and/or a query originated from the Task Manager. According to the system application requirements, nodes may do some computations. After computations, it can pass its data to its neighboring nodes or simply pass the data as it is to the Task Manager. The sensor node can act as a source or sink/actuator in the sensor field. The definition of a source is to sense and deliver the desired information (see Figure 1.1). Hence, a source reports the state of the environment. On the other hand, a sink/actuator is a node that is interested in some information a sensor in the network might be able to deliver. A basic sensor node typically comprises of five main components and they are namely controller, memory, sensors and actuators, communication device and power supply (see Figure 1.2). A controller is to process all the relevant data, capable of executing arbitrary code. Memory is used to store programs and intermediate data. Sensors and actuators are the actual interface to the physical world. These devices observe or control physical parameters of the environment. The communication device sends and receives information over a wireless channel. And finally, the power supply is necessary to provide energy. In wireless sensor networks, power consumption efficiency is one of the most important design considerations. Therefore, these intertwined components have to operate and balance the trade-offs between as small energy consumption as possible and also the need to fulfill their tasks.

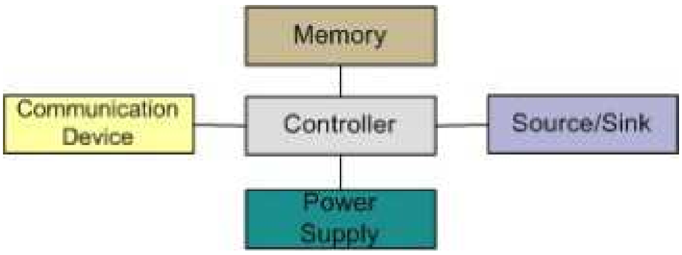

Figure 1: Overview of sensor node hardware components.

1.2.2. Gateways

Gateways allow the scientists/system managers to interface Motes to personal computers (PCs), personal digital assistants (PDAs), Internet and existing networks and protocols. In a nutshell, gateways act as a proxy for the sensor network on the Internet. According to [4], gateways can be classified as active, passive, and hybrid. Active gateway allows the sensor nodes to actively send its data to the gateway server. Passive gateway operates by sending a request to sensor nodes. Hybrid gateway combines capabilities of the *active* and *passive* gateways.

1.2.3. Task Managers

The Task Manager will connect to the gateways via some media like Internet or satellite link [6]. Task Managers comprise of data service and client data browsing and processing. These Task Managers can be visualized as the information retrieval and processing platform. All information (raw, filtered, processed) data coming from sensor nodes is stored in the task managers for analysis. Users can use any display interface (i.e. PDA, computers) to retrieve/analyze these information locally or remotely (see Figure 1.1).

1.3. Sensor Network Challenges

The challenges we face in designing sensor network systems and applications include:

• Limited hardware

Limited amount of hardware resources is used to optimize the maximum output is one of the biggest challenges of sensor networks. Each node in sensor network has limited processing, storage, and communication capabilities, and limited energy supply and bandwidth.

• Limited Support for networking

Peer-to-peer network is used with mesh topology. Network is dynamic, mobile and equipped with unreliable connectivity. No routing protocols or register has been used. Therefore, node itself acts both as a router and as an application host.

• Limited support for software development

The tasks are typically real-time and massively distributed, involve dynamic collaboration among nodes, and must handle multiple competing events. Global properties can be specified only via local instructions. Because of the coupling between applications and system layers, the software architecture must be co-designed with the information processing architecture. Further wireless sensor network uses a wide variety of applications and to impact these applications in real world environments, we need more efficient protocols and algorithms. Designing a new protocol or algorithm address some challenges which are need to be clearly understood. These challenges are summarized below:

• **Physical Resource Constraints**

One of the most important physical constraints is power supply. Effective lifetime of sensor network can be determined by its power supply. Hence, energy consumption is the main design issue protocol. Other constraints are limited computational power and memory size which determines the size of data stored in each sensor node. Therefore, protocols designed should be simple and light weighted. Communication channels are also limited which are shared by all nodes within each other’s transmission range as a result communication delay increases.

• Ad-hoc Deployment

In some applications, ad-hoc deployments of sensor nodes are required with respect to some specific area. The sensor nodes are randomly installed without prior knowledge of infrastructure and topology. In such situation, it is the responsibility of sensor nodes to identify its connectivity and distribution among nodes.

• Fault-Tolerance

A sensor node may fail due to some physical damage or lack of energy. It is up to the communication protocols to lodge these changes in the network.

• Scalability

Generally Hundreds or thousands of sensor nodes are to be deployed in most of the applications. This is the responsibility of the protocols to scale enough to communicate with such large number of sensor nodes.

• Quality of Service

In some real time sensor applications as soon as the data is sensed, it must be delivered in certain period of time, before it becomes obsolete. QOS is the major parameter for such applications.

• Security

Security is very critical parameter in sensor networks, given some of the proposed applications. An effective compromise must be obtained, between the low bandwidth requirements of sensor network applications and security demands for secure data communication in the sensor networks (which traditionally place considerable strain on resources)Thus, unlike traditional networks, where the focus is on maximizing channel throughput with secure transmission.[4]

1.4. Issues in WSN

The major issues that affect the design and performance of a wireless sensor network are as follows:

1) Hardware and Operating System for WSN
2) Wireless Radio Communication Characteristics
3) Medium Access Schemes
4) Deployment
5) Localization
6) Synchronization
7) Network Layer
8) Transport Layer
9) Data Aggregation and Data Dissemination
10) Programming Models for Sensor Networks
11) Middleware
12) Quality of Service
13) Security

2. Literature Review

I.F. Akyildiz, W. Su*, Y. Sankarasubramaniam, E. Cayirci," Wireless sensor networks: a survey", Elsevier Science, 2002, B.V. PII: S13 8 9-1 2 86 (0 1)0 03 0 2- 4[5]

This paper describes the concept of sensor networks which has been made viable by the convergence of micro electro-mechanical systems technology, wireless communications and digital electronics. The flexibility, fault tolerance, high sensing fidelity, low-cost and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. In the future, this wide range of application areas will make sensor networks an integral part of our lives. However, realization of sensor networks needs to satisfy the constraints introduced by factors such as fault tolerance, scalability, cost, hardware, topology change, environment and power consumption. Since these constraints are highly stringent and specific for sensor networks, new wireless ad hoc networking techniques are required. First, the sensing tasks and the potential sensor networks applications are explored, and a review of factors influencing the design of sensor networks is provided. Then, the communication architecture for sensor networks is outlined, and the algorithms and protocols developed for each layer in the literature are explored. Open research issues for the realization of sensor networks are also discussed.

Dervis Karaboga Bahriye Basturk," A powerful and efficient algorithm for numerical function optimization: artificial bee colony (ABC) algorithm", © Springer Science Business Media B.V. 2007 [6]

Artificial Bee Colony (ABC) Algorithm is an optimization algorithm based on the intelligent behavior of honey bee swarm. In this work, ABC algorithm is used for optimizing multivariable functions and the results produced by ABC, Genetic Algorithm (GA), Particle Swarm Algorithm (PSO) and Particle Swarm Inspired Evolutionary Algorithm (PS-EA) have been compared. The results showed that ABC outperforms the other algorithms. This paper compared the performance of the ABC with that of GA, PSO and PS-EA which are also swarm intelligence and population based algorithms as the ABC algorithm. In order to demonstrate the performance of the ABC algorithm, PSO, PS-EA, GA and ABC algorithms were tested on five high dimensional numerical benchmark functions that have multimodality. From the simulation results it was concluded that the proposed algorithm has the ability to get out of a local minimum and can be efficiently used for multivariable, multimodal function optimization. There are several issues which remain as the scopes for future studies such as the investigation of the control parameters' effect on the performance of the ABC algorithm and the convergence speed of the algorithm.

Dervis Karaboga *, Bahriye Akay," a comparative study of Artificial Bee Colony algorithm", Applied Mathematics and Computation 214 (2009) 108–132 [7]

Artificial Bee Colony (ABC) algorithm is one of the most recently introduced swarm-based algorithms. In this work, .ABC employ a greedy selection process between the candidate and the parent solutions. In ABC, on ''employed bees" stage a trial solution is produced for each solution in the population as in the case of DE without depending on the quality of solutions. On''onlooker bees" stage, the solutions with the higher fitness value are used more often than those with less fitness values to produce trial solutions. It means that the promising regions of the search space are searched in shorter time and in detail. This mechanism provides the ABC algorithm a global search ability and prevents the search from premature convergence problem. This feature weakens the dependency of the algorithms' performance on the population size, too. Hence, there is a good balance between the local search process carried out by artificial onlooker and employed bees and the global search process managed by artificial scouts. Therefore, the ABC algorithm produces better results on multimodal and multivariable problems than other algorithms considered in this paper. This work compared the performance of ABC algorithm with those of GA, DE, PSO and ES algorithms on a large set of unconstrained test functions. From the results obtained in this work, it can be concluded that the performance of ABC algorithm is better than or similar to that of these algorithms although it uses less control parameters.

Changsheng Zhang; Yunbin Li; Zhonglin Li; Bin Zhang, "A multi-objective artificial bee colony algorithm for QoS based route optimization problem," Systems and Informatics (ICSAI), 2012 International Conference on, vol., no., pp.1538,1541, 19-20 May 2012.[8]

The QoS based route optimization is a key issue of the wireless network, which is a NPC-hard multi-objective discrete optimization problem. In this paper, an efficient multi-objective artificial bee colony optimization algorithm based on Pareto dominance called MOABC is proposed to tackle this problem. The algorithm was evaluated on a set of different scale test problems and compared with GA based multi-objective optimization algorithm for this problem. The experimental results reveal very encouraging results in terms of the quality of solution and the processing time required.

Nidhi, Mrs. Pooja Mittal," A Swarm Based Approach to Detect Hole In Wireless Sensor Network", IJCSMS International Journal of Computer Science & Management Studies, Vol. 12, Issue 03, September 2012. [9]

We proposed a swarm intelligence based routing algorithm that initiates or call hole detection mechanism. The proposed routing algorithm is similar to most swarm based algorithm the only difference is how it handles when a neighbor do not respond to a route discovery request or when a existing route breaks A Sensor network is a network with large number of sensors in it. The broadcasting and the multicasting are the major communication approaches used in such network to distribute some information over the network or the network part. Because of this the congestion over the network increases. In this present work we have defined a Swarm Based Intelligent approach to perform the reliable packet delivery over the network. Here we have defined an intelligent decision approach to select the next node based on load and response time. The work is about to improve the network throughput as some bad node or the hole occur over the network. The swarm based approach will do the analysis based on the neighboring nodes and will select the effective path for the communication.

3. Problem Formulation

Wireless Sensor Networks consisting of nodes with limited power are deployed to gather useful information from the field. In WSNs it is critical to collect the information in an efficient manner. WSN is applied in routing and difficult power supply area or area that cannot be reached and some temporary situations, which do not need fixed network supporting and it can fast deploy with strong anti-damage. In order to avoid the problem we proposed a new technique called Bio-Inspired mechanism for path optimization. Proposed algorithm can avoid network congestion and then it can prolong the life cycle of the whole network. It optimizes the routing paths, providing an effective multi-path data transmission to obtain reliable communications in the case of node faults. The main goal is to maintain the maximum lifetime of network, during data transmission in an efficient manner. A network always suffers from the problems of broken link or the selfish node problem. The selfish node is a node that accepts the data from other nodes but will not pass it on next node. Because of any reason, if some link fails over the network, it can cause data loss. To minimize the data loss, the selfish node is detected, alternate path is found and selfish node is avoided.

4. Alternate Path Overview

Alternate routing has been explored in several different contexts. Traditional circuit switched telephone networks used a type of multipath routing called alternate path routing. In alternate path routing, each source node and destination node have a set of paths (or multipath) which consist of a primary path and one or more alternate paths. Alternate path routing was proposed in order to decrease the call blocking probability and increase overall network utilization. In compromising or alternate path routing, the shortest path between exchanges is typically one hop across the backbone network; the network core consists of a fully connected set of switches. When the shortest path for a particular source destination pair becomes unavailable (due to either link failure or full capacity), rather than blocking a connection, a compromising path, which is typically two hops, is used. Well known compromising path routing schemes such as Dynamic Nonhierarchical Routing and Dynamic Alternative Routing are proposed and evaluated.

5. Proposed Work

The Three Phases of ABC Algorithm
• Route discovery phase
• Route maintenance phase
• Route failure handling

5.1 Proposed Algorithm

```
Algorithm Bio-Inspire-Mechanism ( )

{
        Create a Network having 'n' Number of Nodes arranged in Rectangular Manner

        Select the Source and Destination from the Network

Transfer the Data from Source towards Destination

Calculate the Threshold using ABC and value of Network Parameter
Select the Source Node as Current Node
        (Current Node (Nd) = Source Node
a:
While (Nd ~= Destination) do
{
Select a Relay Node from Neighbour say Nd and transfer the Data to Relay Node from Current Node(Nd)
Initiate Counter: =1
        While Counter <= Threshold do
        {
                If (Nd Receive Data) then
                        "End Acknowledgement to Nc and Break"
                        Else
                                "Retransmit Data from Nc to Nd and Counter= counter+1
        }
        If ( Counter > Threshold) then
                "Find the Nearest Neighbour as Nc
}
}
```

The proposed work is about to optimization of path in wireless sensor network with the help of artificial bee colony algorithm. In case of selfish node over the network, the network will not work efficiently in case of some dynamic change in the network. The proposed work is about to provide an optimization in QOS in case of selfish node. In this work we have improve the Artificial bee colony algorithm by generating the alternate path through nearest neighboorhood algorithm. To optimize the alternate path stable links are also included dynamically.

6. Conclusion

Applications of this approach can also be extended to other areas such as shortest distance optimization or base station construction where it is a challenging issue to determine the minimum number of base stations required to meet optimal radio transmission coverage while minimizing overall construction costs.

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