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Reserach Article

SECURE ROUTING OF WBAN WITH ELEPHANT HERDING OPTIMIZATION

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A R T I C L E I N F O

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A B S T R A C T

Transmission healthcare data is focused in this paper. WBAN is kind of MANET that is used for transmission healthcare data. Efficient parameters for secure routing in WBAN are specified and then they are optimized simultaneously. Secure routing in WBAN is modeled as an optimization problem. Since parameters of secure routing are individuals and the structure of WBAN is dynamic, optimization is executed simultaneously. Multi-objective optimization algorithms have ability to optimize multi variables simultaneously. Elephant Herding Optimization as a new and powerful multi-objective optimization algorithm is used in this paper.

INTRODUCTION

Nowadays web-based application has rigorous growth. Mobile Ad hoc Network (MANET) is popular type of web. Healthcare data are crucial data that transmitted over MANET. Transmission of healthcare data is need for hospital to monitor patients. The network of healthcare data is named as Wireless Body Area Network (WBAN) that has wearable or embedded components. Components of WBAN (such as sensors) can be used for getting information from patients. Data from patients is helped medical staff to improve treatment with remote control on WBAN components. Actually, transmission of data packets requires a secure routing mechanism. Unfortunately, traditional mechanisms have two important problems: first of all, they do not consider all effective parameters for secure routing simultaneously and secondly, they are not proper for real-time applications in the dynamic structure. Aim of this paper is presenting an approach at covers problems of traditional mechanisms. In the first step, we must recognize important parameters. In the second step, we use recognized parameters in the model of network. We present the network as a multi-objective model.

This paper is organized as follow: in the section 2, we study the previous researches. However, each work is based in its defaults, we can find useful parameters with withdraw unimportant things. In section 3, we describe multi-objective model briefly and then optimization algorithms which are used in this paper. In section 4, experimental results of different algorithms are presented. Finally, section 5 in conclusion.

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Previous Works

Allocation proper bandwidth is challenged concept in secure routing. The elastic optical networks can provide bandwidth allocation to each connection request properly with using OFDM (Orthogonal Frequency Division Multiplexing) technology. The elastic optimal network method is flexible, so it gets high spectrum utilization. The elastic optical network divides the high-speed data stream into orthogonal low-speed slots. Xuan *et al*. provides a static scheme for routing and spectrum assignment problem [1]. Authors stablish an optimization model. Proposed model has two phases and in each phase it optimize just one object. According to their research, there are two objects with tree constraints to establish a connection. This routing method wants to minimize the maximum index of used slots and minimize the ration of blocked resources with constraints: 1- the index of slots must be identical (consistency) 2- a large connection request cannot be divided into several small connection requests (continuity) 3- each slot should be assigned to one connection.

Actually hardware/energy consume of nodes is very important in secure routing. Unfortunately, previous works in this area cannot help us. For example, Yuan *et al*. propose an algorithm, which is called TSRAL, to rout data packets [2]. Proposed algorithm compare the measurement of all available path with a threshold metric and select best of them. This algorithm cannot be accepted, because it static and also it considers all parameters in one formula and assign same weight to all parameters.

Since wide rigorous network application, there is need a content-centric in front of host-centric. Liu *et al*. describe the features of information-centric mobile ad hoc network (ICMNET) [3].

Presented model must be powerful against attacks. Black hole attack (BLA) is one kind of different attacks that affects data collection wireless networks. In this attack, adversary drops all data packets of an especial node that are routed, so data cannot be usable or forward to the sink. In some researches to avoid BLA, data packet is divided into M shares, which are sent to the sink via different routes. Unfortunately, this technique is energy consume. Another method is routing data packets is trust path, so there is need to a trustable measurement. Obtaining the trust of a node is difficult and also is unclear.

Liu *et al*. proposes a new method that active detection routing to address BLA [4]. Their scheme has better energy efficiency than the previous ways. Proposed scheme has two stages: at first nodes with high trust are chosen and then secondly route along the successful detection. Although their scheme considers energy consumption with high trusty routing, but they suppose adversary is identified and also it is nodal.

Shen *et al*. depicts a scenario that individuals (objects) are in the Incompletely Predictable Network (IPN) [5]. It proposed a novel protocol named as Direction Density-based Secure Routing Protocol (DDSRP). In IPN, nodes are stable over a long period of time. Density is defined as similarity between coordinated destination and message transmitted. In proposed scheme, data-packets moving toward links with high density. Anand *et al*. propose a routing mechanism to ensure security in Mobile Ad hoc Network (MANET) [6]. There is no central authority in MANET. Each node performs routing role to route data packets from source to destination through the network. They have some limitations such as battery power ad bandwidth. Authors propose a scheme that creates a blend of both local and global reputation over a dynamic model. Actually their work discusses about well behavior after node fail. Khan *et al*. uses MAC layer in Mesh Networks [7]. In their approach, information of two communicated hops are kept to increase security of routing. Authors consider two efficient parameters for their proposed mechanism: 1-security and 2-data-rate reduction. They use multi-hop in their scenario.

Although security is considered in the routing protocols in wireless ad hoc networks and in the most of them is derived with extension of cryptographic and trust-based exiting routing protocols, secure routing problems are not solved in wireless ad hoc networks totally. Shcherba *et al*. propose an approach with using the flat rate trust levels, so they enhance the flexibility. They use Dijkstra algorithm.

We can extract several parameters from previous research: 1-number of slots (this parameter also presents density and reputation of information) 2-cost (this parameter include energy/hardware, price etc which must be paid to transmit healthcare data) 3-truthworthy

Multi-Objective Optimization

Multi-objective optimization (MOO) is a technique that is used in many fields of real world. When we want find optimum values for multi parameters simultaneously, we use multi-objective optimization. However, there are another technique optimize multi parameters, multi-objective optimization demonstrates it is better. For example, in "aggregation" technique, we try to combine multi parameters in one formula. We do combination with assigning weights to parameters. Unfortunately, there is not a professional method for achieving the weights. Thus we use "try and error" method inevitably. Of course "try and error" method is not an accurate method and also is not an useful method in a dynamic environment same as network.

MOO is necessary when multiple cost functions are considered in the same problem. The aim of MOO is to tune the decision variables to satisfy all objective functions with optimum value. This class of problems is modeled by (1).

$$\text{Optimize} \quad [F_1(X), \cdots, F_k(X)]$$

$$\text{Subject to: } g_1(X), \cdots, g_m(X) \leq 0; h_1(X), \cdots, h_p(X) = 0 \qquad (1)$$

Where k is the number of objective functions, X is the decision vector, m is the number of inequality constraints, and p is the number of equality constraints.

This goal causes a difference between these algorithms and their ancestor, Single-Objective Optimization, which is based on the concept of the best solution, while MOO utilizes the concept of dominate solution. Dominance as:

$$\vec{U} = (u_1, \cdots, u_n) \prec \vec{V} = (v_1, \cdots, v_n) \text{ iff } \forall i \in \{1, \cdots, n\}: u_i \leq v_i \text{ ; } \exists j \in \{1, \cdots, n\}: u_j < v_j \qquad (2)$$

In other words, a vector $\vec{U} = (u_1, \cdots, u_n)$ dominates another vector $\vec{V} = (v_1, \cdots, v_n)$ if and only if $\vec{U}$can reach the optimal value for some criteria without causing a simultaneous non-optimal value for at least one criterion. If two vectors cannot dominate each other, they are called non-dominated vectors.

Elephant Herding Optimization

Swarm Intelligence (SI) algorithms concentrate to study the group behavior from the local collaboration of the individuals with each other and with their environment.

Elephant Herding Optimization is one of the Swarm Intelligence (SI) Algorithms [9]. Animal behaviors inspire SI. Elephants live in clan together and under the leadership of a matriarch, so this habitation can be used to solve the optimization problems. In Elephant Herding Optimization (EHO), each elephant updates its position base on its current position and matriarch.

In nature, elephants are social mammals. An elephant group consists several clans under leadership of a matriarch. Female elephants prefer to live in family group, while male elephants tend to live in isolation. In order to model the behavior of elephant herder, we consider three rules:

1. The elephant population consists of some clans, and each clan has fixed number of elephants.
2. A fixed number of male elephants will leave their group and live solitarily.
3. The elephants in each clan live together and under leadership of a matriarch.

Thus we design two operators: 1-update and 2-separate. In multi-objective, these operators (update and separating) are defined according to dominance states. Actually, we can consider multiple clans, but in this work there is just one clan for simplicity.

$$V_i \prec V_j \Longrightarrow V_j^{new} = V_i$$

$V_j < V_i \Longrightarrow V_i^{new} = V_j$

Experimental Results

As we study in section 2, we must optimize three parameters. Since parameters of secure routing are individual from each other, we have to optimize them simultaneously. In this paper, Elephant Herding Optimization algorithm is used for this manner. Thus we can model the problem as follow:

$Optimize\ Num, Cost, Tru$
$Such\ That{:}\ Num \geq DN, Tru \geq DT$

'Num', 'Cost', 'Tru' are number of slots, cost and trustworthy respectively. Optimization of secure routing parameters means maximization of 'Num' and 'Tru' and minimization of 'Cost'. 'DN' is the minimum value for slots number. Of course 'DN' is determine according to structure of network (how many bit can be transmitted over a slot), we can set 'DN' ordinary because our objective is presenting of Elephant Herding Optimization efficiency. Another important parameter is 'DT' which is showed minimum value for trustworthy.

Elephant Herding Optimization is an evolutionary algorithm, so needs to set maximum number of epochs. We set it as 100, but there is no classical way for setting. After 100 epochs, 'Num' is 15, 'Cost' is 23 and 'Tru' is 4.

CONCLUSION

In this paper we study about transmission for healthcare data over WBAN. First of all, we present the important parameters for secure routing. In the second step, we use Elephant Herding Optimization algorithm for achieving optimum values for important parameters. Elephant Herding Optimization as an evolutionary algorithm needs to tune some variables. Actually with wright tuning of Elephant Herding Optimization parameters, we can achieve better solution.

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