Novel Metaheurist Technique for Attack Detection Technique in Wireless Multimedia Sensor Networks

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ABSTRACT
WMSN is definitely a special type of WSN which will good sense and move scalar data in addition to multi-media data, which is, impression, audio, and online video revenues, within real-time in addition to non-real-time. In WMSN, the goal is to send information from a source to a destination node in peer-to-peer connection through intermediate mobile nodes, i.e., across multiple hops. In this paper, a novel metaheuristic technique i.e., triangular mutation based particle swarm optimization is proposed to detect attacks in wireless multimedia networks. The performance of the original Triangle link quality metric and minimum inter-path Interference based Geographic Multipath Routing (TIGMR) protocol based geographic multipath routing is compared with this new implemented approach, called here as An Ad Hoc On-Demand Distance Vector (AODV)-PSO. Two metrics were used to evaluate the performance of the algorithm: Bit Error Rate. We observed that the AODV-PSO outperformed the original AODV protocol in the scenarios studied in this paper.

Keywords
Wireless Multimedia Sensor Network, Triangular Mutation based Particle Swarm optimization (PSO and AODV routing protocol.

1. INTRODUCTION
GREAT developments in multimedia devices and wireless applications have been observed in the last years. It has increased mainly due to the benefits supported by these technologies when compared to wired networks, such as installation facilities and portability. An invisible multi-media sensor system (WMSN) includes a large volume of interconnected sensor nodes (SNs) who have the capability to sense the particular physical natural environment capabilities like heat range, pressure, dampness, mild, and seem and concurrently interact jointly over the cellular medium. These devices are often used by people who need connectivity and flexibility. Among the wireless communication systems, wireless multimedia sensor networks have been pointed as a great alternative for the future, since they can provide the same services of a conventional wireless network, without the requirement of a base station for establishing communication [1].

The enhancements in different systems have resulted in the roll-out of minor and low-cost multi-media gadgets similar to online video digital cameras and microphones that could be bundled produce a sensor node. Most of these products are included in exclusive forms of cellular sensor networks, termed cellular multi-media sensor networks (WMSNs). WMSN is definitely a special type of WSN which will good sense and move scalar data in addition to multi-media data, which is, impression, audio, and online video revenues, within real-time in addition to non-real-time.

In WMSN, the goal is to send information from a source to a destination node in peer-to-peer connection through intermediate mobile nodes, i.e., across multiple hops. Accordingly, the network nodes also act as routers where the management and control are distributed among the mobile nodes. Therefore, the traditional wired network routing algorithms cannot be effectively applied to ad hoc networks, since they present some issues that are very peculiar and different from wired networks.

This paper is organized as follows. Section II presents the literature survey. Section III gives methodology that how to work works our methodology. Section IV presents the proposed modifications to the AODV protocol based on the connectivity and the PSO technique. Section V describes the simulation scenario and results. Finally, Section VI brings the conclusion and suggestion for future work.

2. LITERATURE SURVEY
Various protocols are used to solve the multihop routing tricky, a few once depend on dissimilar assumptions and features. Certain depend upon transmission device to discover routes over the network [2], [3].The leading protocol for routing is the AODV algorithm [3], [4], [5]. This protocol is reactive, meaning that it does not require the nodes to maintain routes to their destinations that are not in active communication. AODV routing also provides two different mechanisms to recover routes when a link break in active routes occurs due to changes in network topology.

In the first case, the route repair can be initiated locally at the node located immediately upstream of the broken link. In the second case, the route repair can be made by the source node after receiving a notification of the route failure [5]. In the AODV route recovery mechanisms, for networks with limited diameters, error messages can be propagated back to the source node relatively quickly, and a repairing action is performed. However, for networks with larger diameter and longer paths, the error message may have to propagate for more hops to reach the source which may increase the time to repair.

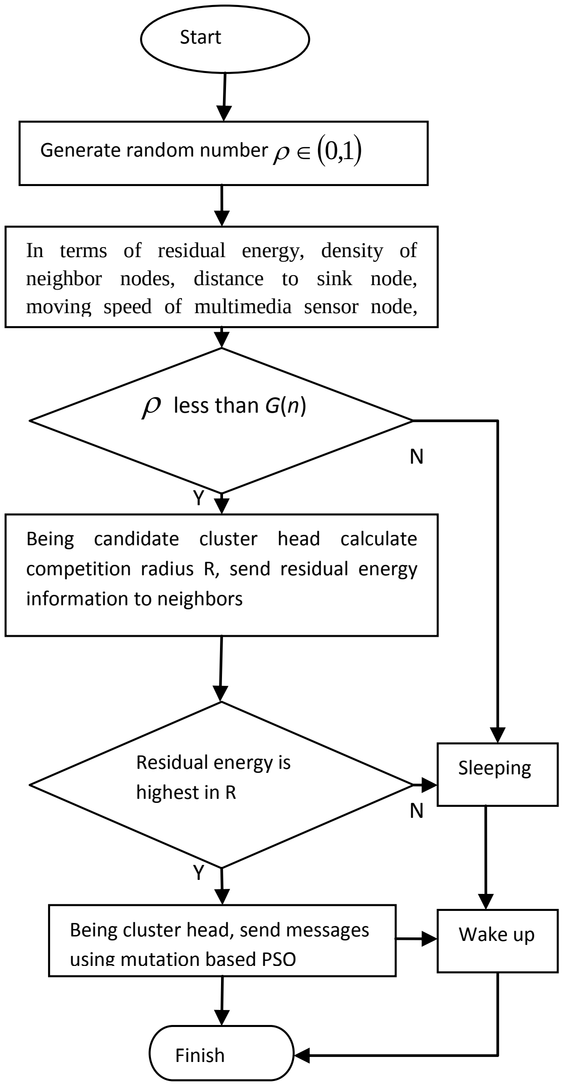
Hence, this mechanism can become ineffective for more stressful scenarios. One can observe that, in the current AODV algorithm implementation, the protocol chooses to do either a source repair or a local repair based only on the number of hops involved across the path [6]. In addition, we consider to use a Computational Intelligence technique called Particle Swarm Optimization (PSO) [7], to generate the appropriate composition of weights for all considered parameters in AODV route recovery, in order to improve the choice in local repair decision aiming to reduce data packet drop ratio.

Abbas and Yu designed a video surveillance system for linear wireless multimedia sensor networks [25]. Abbas et al. reliability and end-to-end delay monitoring for outdoor and indoor environments for wireless multimedia sensor networks [26]. Patel and Chaudhary improved multimedia compression and transmission technique to aid energy efficient wireless multimedia sensor network [27]. Chatei et al. utilized an efficient coding technique to handle the intercommunication in wireless multimedia sensor networks [28]. Lin et al. designed a reconstruction algorithm for lost frame of multiview videos in wireless multimedia sensor network based on deep learning multilayer perceptron regression [29]. Agnihotri et al. simulated different MAC protocol for wireless multimedia sensor network to restrict the access of resources and to avoid congestion [30]. However, techniques used in [25], [26], [27], [28], [29] and [30] are unable to resist various types of security attacks.

3. PROPOSED METHODOLOGY

For the simulations performed in this work, we used the PSO with global topology, which can make search for appropriate parameters to the AODV decision function. The global topology converges fast and can be used for this problem since the search space is not highly multimodal. In this kind of topology the particles have knowledge about the position of all the other particles in the swarm, being able to know which one has the best position [20].

The proposed technique adopts triangular mutation based PSO to find the optimized path among cluster heads. There is a multi-hop communication mechanism between cluster heads, instead of a single-hop communication mechanism. As Fig.3 shows, with the increase of the distance between a cluster head and the sink node, the energy consumed of the multi-hop communication mechanism is less than the single-hop communication mechanism in networks with larger scales. So it's wise to choose the multi-hop routing mechanism to decrease energy consumption, especially for WMSN including multimedia nodes.



PSO initially provides a set of random values for the weights and velocities and a network scenario is executed using them. Equation (1) is utilized to update the velocities of each particle in the swarm. At the end of the execution, data packet delivery delay measured is taken as the PSO fitness and this process is repeated until the best values for the weights is reached according to the stopping criteria.

Thus, the evaluated objective function (fitness) of each particle is the average data packet delivery delay for each network scenario simulated, so that this measure could be minimized over the course of iterations. This process is described in Algorithm 1.The stopping criteria employed was the number of iterations. Therefore, regarding the computational complexity of the PSO technique, considering that the algorithm is running with Pparticles and it evaluates each particle at each iteration, the execution time is roughly $P\ N\ T$, where $N$is the number of iterations and $T$is the time to evaluate a scenario with the predefined set of parameters (*i.e.*, *A*, *B*, *C* and *D*).

The flow chart of proposed methodology is shown below:

Algorithm 1: PSO algorithm for AODV routing.

1. $\boldsymbol{Start\ Swarm}$();

→ Set particle dimensions randomly from considered search space

→ Initialize particle positions and velocity as in Equation (1)

2 $\boldsymbol{repeat}$

3 $\boldsymbol{for}$ $eachParticle$ $\boldsymbol{do}$

4 $\boldsymbol{for}$ $eachDimension$ $\boldsymbol{do}$

5 $update\ Velocity\ Position$();

→ Update particle velocity and position as in Equation (1)

6 $\boldsymbol{end}$

7 $\boldsymbol{calculateFitness}$;

// For each particle, calculate its fitness value from the data packet delivery delay measured

8 $\boldsymbol{end}$

9 $\boldsymbol{Uptade\ leader}$;

→ // If the fitness value is better than the previousP_{best}, set the current fitness value as the new P_{best}

10 if $currentFitness < bestIndividualFitness$**11.then**

$bestIndividualFitness = currentfitness$;

12 end

13 $\boldsymbol{if}$

$currentFitness < bestNeighborhoodFitness$

14 $\boldsymbol{then}$

$bestNeighborhoodFitness = currentfitness$;

15 end

→ Best particle is selected as G_{best}

16$\boldsymbol{until}$ $stoppingCriteria$;

In the most common implementations of PSO, particles move through the search space using a combination of an attraction to the best solution that they individually have found, and an attraction to the best solution that any particle in their neighborhood has found during the search process so far. In PSO, a neighborhood is defined for each individual particle as the subset of particles which it is able to communicate with [20].

Particle swarm optimization is initialized with a population of random solutions for which is also assigned a randomized velocity. The potential solutions, called particles, are then "flown" through the hyperspace. Each particle keeps the coordinates of the position in the hyperspace which is associated with the best solution it has achieved so far$\vec{p}_i$. The best solution is determined according to the fitness evaluation at the points considered along the trajectories of the particles. The value of the fitness is also stored. This value is often called P_{best}. Another "best" value is also tracked: the "global" version of the particle swarm optimizer G_{bset} which keeps track of the overall best value, and its location, obtained thus far by any particle in the population $\vec{p}_g$.

The particle swarm optimization concept consists of, at each time step, changing the velocity (accelerating) each particle toward its$\vec{p}_i$ and $\vec{p}_g$(global version). Acceleration is weighted by a random term with separate random numbers being generated for acceleration toward $\vec{p}_i$and $\vec{p}_g$. The previous velocity of the particle is also considered for changing the velocity of the particle.

The particles move throughout the search space by a fairly simple set of update equations. The algorithm updates the entire swarm at each time step by updating the velocity and

position of each particle in every dimension according to [21]

$\vec{V}_i(l+1) = \lambda\vec{V}_i(l) + c_1\varepsilon_1\left[\vec{p}_i(l) - \vec{P}_i(l)\right] + c_2\varepsilon_2\left[\vec{p}_g(l) - \vec{P}_i(l)\right]$ (1)

where for each particle there are three vectors: a position vector $\vec{P}_i$, a velocity vector $\vec{V}_i$and the vector which stores its best found position $\vec{p}_i$, in which the subscript $i$represents the index of the particle. These values represent the individual knowledge of the particle. Besides these three vectors, the

PSO algorithm should keep another array that stores the best position found by any particle in the neighborhood, representing the group's experience $\vec{p}_g$. The velocity vector $\vec{V}_i$directly influences the direction that the particle will take on each iteration, allowing the particles to reach different regions of the search space. The knowledge acquired by the particle in accordance with their own experience is represented in Equation (1). $c_1\varepsilon_1\left[\vec{p}_i(l) - \vec{P}_i(l)\right]$is called the cognitive component. This term represents how much, from its current position $\vec{P}_i$, the particle is far away from its best position ever found $\vec{P}_i(l)$.

The experience of an entire neighborhood is represented by the social component, which appears in Equation (1) as $c_2\varepsilon_2\left[\vec{p}_g(l) - \vec{P}_i(l)\right]$. This component corrects the velocity of particle $i$based on the best position found within its neighbourhood$\vec{p}_g(l)$. For a neighborhood with the size of the entire swarm, this term represents the correction of particle velocity for the whole group. *In this case, the particle will be aware of the best overall position within the group, and thus, adjust its position relative to the whole swarm. The terms c_1 and c_2 are acceleration constants and assume real values [20]. These values are used to balance the influence of the cognitive component and social component, defining the search behavior of the swarm. The terms $\varepsilon_1$and $\varepsilon_2$are generated separately from an uniform distribution between 0 and 1 [21].

The inertia weight parameter ω was used to strike a better balance between global exploration and local exploitation by adjusting the influence of the previous particle velocities on the optimization process, described in Equation (1).

The change of velocity modifies the position of particles making them to move through the hyperspace over successive iterations. Upon updating their information, the swarm particles reorganize their experiences. Depending on the problem that the PSO will handle, either minimizing or maximizing a function, each particle will adjust its objective function (fitness) to converge towards a possible solution.

4. RESULT ANALYSIS

The paper simulates and compares proposed technique with the exiting one. Two scenarios are designed: scenario 1 with 100*m* * 100*m* scale, 100 nodes distributed randomly and homogeneously, and a sink node located on（50,100）, while scenario 2 with 200*m* * 200*m* scale, 200 nodes distributed randomly and homogeneously, and a sink node located on（100,200）. Parameters are listed as Table 1.

Table 1. Parameters setting

Parameters	Values
Communication channel bandwidth	1 Mb/s
Nodes initial energy E_{max}	Good
Circuit energy consumed for unit sending or receiving E_{elec}	50 nJ/bit
Coefficient of free space loss model energy dissipation ε_{fs}	10p J/bit/m^2
Coefficient of multi-path fading model energy dissipation ε_{mp}	0.0013pJ/bit/m^4
Coefficient of data aggregation energy dissipation E_{DA}	50 nJ/bit/signal
Data package length	4000bit
Broadcast message length	100bit
Probability of one node being a cluster head p	0.05
Maximum moving speed of nodes	2m/s
Weight of residual energy w_1	0.2
Weight of density of neighbor nodes w_2	0.2
Weight of distance to sink node w_3	0.3
Weight of moving speed w_4	0.3
Influence factor of competition radius α	0.5
Number of intelligent ants M	30
Maximum iteration counter NC_{max}	100
Coefficient of pheromone enhance Q	100
Coefficient of volatile quantity of pheromone θ	0.3
Influence factor of energy α_1	1
Influence factor of distance α_2	5
Pheromone heuristic factor β_1	1
Expectation heuristic factor β_2	3.5

Aiming to produce results relevant to this study, one performance measure was chosen for our analysis: Bit Error Rate. The measures of performance are explained below:

1. BER (Bit error rate)

It is defined as the rate at which errors occur in a transmission system. This can be directly translated into the number of errors that occur in a string of a stated number of bits. The definition of bit error rate can be translated into a simple formula:

$$BER = \frac{Number\ of\ errors}{Total\ number\ of\ bits\ sent}$$

Table II is indicated the quantized research into the Bit error rate. As Bit error rate ought to be lower which implies proposed algorithm is indicating the superior results when compared to access methods as theBit error rateis lower in each case.

Table 2. Bit error rate Evaluation

No. of Nodes	Existing Approach	Proposed Approach
100	4.8811	4.5455
110	4.9596	4.5060
120	4.8571	4.5565
130	5.0051	4.3399
140	5.1406	4.5284
150	5.0313	4.4385
160	5.3450	4.4963
170	5.1771	405253
180	4.9991	4.4236
190	5.1614	4.5026
200	5	4.5104

Figure 3 indicates the comparison of Bit error rate between existing and the proposed method wherever y-axis indicate metric value as well as x- axis indicates number of nodes Here, red line indicates the proposed technique and blue line indicate the previous one. In our case the proposed Bit error rate are comparatively lower than existing one.

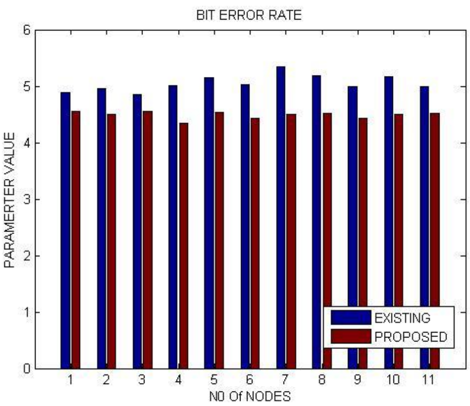


Figure 3: Graphical representation of Bit error rate

5. CONCLUSION

This paper proposes an improved protocol AODV-PSO which selects cluster heads in terms of the residual energy, the neighbor nodes density, the distances to the sink node, and the mobility of nodes, based on traditional TIGMR protocol, and constructs clusters considering the residual energy of cluster heads and the distances to the sink node, and introduces ACO algorithm among cluster heads for data transmitting.

Figures/Images in text as close to the reference Also AODV-PSO considers the concept that the scale of clusters decrease with the decrease of the distance to the sink node. In this way, the number of cluster heads near the sink node is more than that of cluster heads far from the sink node. Thus, the cluster heads near the sink node conserve more energy for transmitting data from remote cluster heads, thereby prolonging the lifetime of the network.

The process of AODV-PSO includes cluster heads selection according to the improved threshold, clustering, cluster heads distributing time slices to every cluster member in terms of TDMA regularity, constructing routing list, cluster members transmitting sensed data to clustreheads, cluster heads processing data aggregation and transmitting data to next cluster head according to the routing mechanism, until to the sink node. When several cluster heads don't have enough residual energy to transmit one frame, cluster reconstruction is needed, and it works like above process. The simulation results show that AODV-PSO is more energy-efficient than TIGMR, thereby prolongs lifetime of the networks.

The number of alive nodes and the average energy consumed in the networks are chosen as the evaluating parameters which are not universal in all WSNs application scenarios. In order to evaluate the performance of routing protocols objectively, the future works should include improving algorithm simulations with a set of QoS, such as packet loss ratio and time delay. Moreover, the simulation platform randomly distributes 100 and 200 sensor nodes respectively in $100m \times 100m$ and $200m \times 200m$ network scales, which are smaller in nodes numbers and scales compared to real application. Therefore larger amount of sensor nodes and scales should be simulated with the proposed algorithm in the future.

The performance of the original TIGMR protocol based geographic multipath routing is compared with this new implemented approach, called here as AODV-PSO. Two metrics were used to evaluate the performance of the algorithm: Bit Error Rate. We observed that the AODV-PSO outperformed the original AODV protocol and has been mean improvement 6% as compared to previous one in Bit Error Rate.

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