An Particle Swarm Optimization Based Wakeup Scheduling Algorithm for Wireless Sensor Network

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ABSTRACT
Wireless sensor networks include a large number of wireless Sensor nodes to gather the information from its environment. These sensor nodes for various applications are usually designed to work in conditions where it may not be possible to recharge or replace the batteries of the nodes ,Sleep/wake-up scheduling is one of the fundamental problems in wireless sensor networks, since the energy of sensor nodes is limited and they are usually unrechargeable. The purpose of sleep/wake-up scheduling is to save the energy of each node by keeping nodes in sleep mode as long as possible (without sacrificing packet delivery efficiency) and thereby maximizing their lifetime. In this project, a self-adaptive sleep/wake-up scheduling approach is proposed.pso optimization used to choose a best sleep and wake up scheduling for improved performance matlab tool has been used to implement our proposed algorithm and to evaluate a performance

INTRODUCTION

In recent years, wireless sensor networks (WSNs) haveemerged as a new category of networking systems withlimited computing, communication, and storage resources. A
WSN consists of nodes deployed to sense physical or environmentalconditions for a wide range of applications, suchas environment monitoring [1], scientific observation [2],emergency detection [3], field surveillance [4], and structuremonitoring [5]. In these applications, prolonging the lifetime ofWSN and guaranteeing packet delivery delays are critical forachieving acceptable quality of service.
Many sensing applications share in common that their sourcenodes deliver packets to sink nodes via multiple hops, leadingto the problem on how to find routes that enable all packetsto be delivered in required time frames, while simultaneouslytaking into account factors such as energy efficiency and loadbalancing. Many previous research efforts have tried to achievetradeoffs in terms of delay, energy cost, and load balancingfor such data collection tasks
In order to save more idle energy, it is necessary tointroduce a wake-up mechanism [3] for sensor nodes in thepresence of pending transmissions. The major objective of awake-up mechanism is to maintain network connectivitywhile reducing the idle state energy consumption. Existingwake-up mechanisms fall into three categories: on-demandwake-up [4], [5], scheduled rendezvous [6], [7], and asynchronous
wake-up [8], [9], as pointed out by the previouswork [9].In on-demand wake-up mechanisms [4], [5], [10], out-ofbandsignaling is used to wake up sleeping nodes in an ondemandmanner. For example, with the help of a pagingsignal, a node listening on a page channel can be woken up.
As page radios can operate at lower power consumption,this strategy is very energy efficient. However, it suffersfrom increased implementation complexity.In scheduled rendezvous wake-up mechanisms, lowpower
sleeping nodes wake up at the same time periodicallyto communicate with one another. Examples includethe S-MAC protocol [6], [7] and the multiparent schemes
protocol [3].The third category, asynchronous wake-up [9], [11], is also
well studied. Compared to the scheduled rendezvous wakeupmechanism, asynchronous wake-up does not requireclock synchronization [12]. In this approach, each nodefollows its own wake-up schedule in idle state, as long as thewake-up intervals among neighbors overlap. To meet this
requirement, nodes usually have to wake up more frequentlythan in the scheduled rendezvous mechanism. However,there are many advantages of asynchronous wake-up, suchas easiness in implementation and low message overhead forcommunication. Furthermore, it can ensure

network connectivityeven in highly dynamic networks.
Related work

Y.Xiaoet al[1] proposed here the fundamental performance limits of medium access control (MAC) protocols for particular multi hop, RF-based wireless sensor networks and underwater sensor networks. A key aspect of this study is the modeling of a fair-access criterion that requires sensors to have an equal rate of underwater frame delivery to the base station. Tight upper bounds on network utilization and tight lower bounds on the minimum time between samples are derived for fixed linear and grid topologies.

C. Chen et al[2] proposed in this paper a novel distributed consensus filter to solve the target tracking problem. Two criteria, namely, unbiasedness and optimality, are imposed for the filter design. The so-called sequential design scheme is then presented to tackle the heterogeneity of sensors. The minimum principle of Pontryagin is adopted for type-I sensors to optimize the estimation errors. As for type-II sensors, the Lagrange multiplier method coupled with the generalized inverse of matrices is then used for filter optimization.

O. A. Basir et al[3] proposed in this paper Semi-Flocking, a biologically inspired algorithm that benefits from key characteristics of both the Flocking and Anti-Flocking algorithms. The Semi-Flocking algorithm approaches the problem by assigning a small flock of sensors to each target, while at the same time leaving some sensors free to explore the environment.
Yanjun Yao et al[4] proposed both a centralized heuristic to reduce its computational overhead and a distributed heuristic to make the algorithm scalable for large-scale network operations. We also develop EDAL to be closely integrated with compressive sensing, an emerging technique that promises considerable reduction in total traffic cost for collecting sensor readings under loose delay bounds.

Xiannuan Liang et al[5] presents in this paper a novel bio-inspired approach to determine group size by researching and simulating primate society. Group size does matter for both primate society and digital entities. It is difficult to determine how to group mobile sensors/robots that patrol in a large area when many factors are considered such as patrol efficiency, wireless interference, coverage, inter/intragroup communications, etc.

Yongfang Liu et al[6] proposed here the protocol only requires a binary information between the neighbouring agent. By designing a carefully constructed Lyapunov function, the distributed finite-time tracking problem is solved if the sub-topology among the followers is connected and

Xuxun Liu et al[7] proposed here a deployment strategy for multiple types of requirements to solve the problem of deterministic and grid-based deployment. This deployment strategy consists of three deployment algorithms, which are for different deployment objectives. First, instead of general random search, we put forward a deterministic search mechanism and the related cost-based deployment algorithm, in which nodes are assigned to different groups which are connected by near-shortest paths, and realize significant reduction of path length and deployment cost.

Kuizhanget al[8] proposed a novel sleep scheduling method to reduce the delay of alarm broadcasting from any sensor node in WSNs. Specifically, we design two determined traffic paths for the transmission of alarm message, and level-by-level offset based wake-up pattern according to the paths, respectively. When a critical event occurs, an alarm is quickly transmitted along one of the traffic paths to a center node, and then it is immediately broadcast by the center node along another path without collision.

Shouwen Lai et al[9] proposed in this paper two such schemes: cyclic quorum system pair (cqs-pair) and grid quorum system pair (gqs-pair). The cqs-pair which contains two cyclic quorum systems provides an optimal solution, in terms of energy saving ratio, for asynchronous wake-up scheduling. To quickly assemble a cqs-pair, we present a fast construction scheme which is based on the multiplier theorem and the (N,k,M, l)-difference pair defined by us. Regarding the gqs-pair, we prove that any two grid quorum systems will automatically form a gqs-pair.

Beakcheol Jang et al[10] presents In this paper,an energy efficient MAC protocol for WSNs that avoids overhearing and reduces contention and delay by asynchronously scheduling the wakeup time of neighboring nodes. To validate our design and analysis, we implement the proposed scheme on the MicaZ platform. Experimental results show that AS-MAC considerably reduces energy consumption, packet loss and delay when compared with SCP-MAC.

Ness B. Shroff et al[11] proposed here,first study how to optimize the anycast forwarding schemes for minimizing the expected packet-delivery delays from the sensor nodes to the sink. Based on this result, we then provide a solution to the joint control problem of how to optimally control the system parameters of the sleep-wake scheduling protocol and the anycast packet-forwarding protocol to maximize the network lifetime, subject to a constraint on the expected end-to-end packet-delivery delay.

Yanjun sun et al[12] proposed here evaluate of pw-mac on a testbed of micaz motes and compare it to x-mac, wisemac, and ri-mac, three previous energy-efficient mac protocols, under multiple concurrent multihop traffic flows and under hidden-terminal scenarios and scenarios in which nodes have wakeup schedule conflicts.

Kevin s.chan et al[13] proposed here pros and cons of each modeling and optimization technique for in-depth understanding. Further, we classify existing approaches based on the types of objectives and investigate main problem domains, critical tradeoffs, and key techniques used in each class.

Cheng-fuchou et al[14] proposed a joint design of asynchronous sleep-wake schedules and opportunistic routing, called ASSORT, to maximize the network lifetime. Simulation results show that ASSORT effectively achieves network lifetime extension compared with other routing schemes.

G.Maxwell et al[15] proposed here the development of a novel pattern recognition system using artificial neural networks (ANNs) and evolutionary algorithms for reinforcement learning (EARL). The network is based on neuronal interactions involved in identification of prey and predator in toads. The distributed neural network (DNN) is capable of recognizing and classifying various features. The lateral inhibition between the output neurons helps the network in the classification process - similar to the gate in gating network.

Formulation of the Problem

As described in Section I, the research of sleep/wake-upscheduling studies how to adjust the ratio between sleepingtime and awake time of each sensor in each period as shownin Fig. 2.

According to Fig. 2, formally, we have the followingdefinitions.

Definition 1 (Sleep): A sensor cannot receive or transmitany packets when it is sleeping, i.e., in sleep state. A sensorin sleep state consumes very little energy.

Definition 2 (Wake-Up): A sensor can receive and transmitpackets when it is awake, i.e., in wake-up state. A sensor inwake-up state consumes much more energy compared to sleepstate.

Definition 3 (Sleep/Wake-Up Scheduling): Sensors adjust thesleeping time length and the awake time length in each periodin order to save energy and meanwhile guarantee the efficienttransmission of packets.

Generally, the radio transceiver in a sensor node has threemodes of operations (termed actions): 1) *transmit*; 2) *listen*;and 3) *sleep* [31]. In transmit mode, the radio transceiver cantransmit and receive packets. In listen mode, the transmittercircuitry is turned off, so the transceiver can only receive packets.

In sleep mode, both receiver and transmitter are turned off.

Typically, among these actions, the power required to transmitis the highest, the power required to listen is medium and thepower required to sleep is much less compared to the other twoactions. The example provided in [20] shows these power levels:81 mW for transmission, 30 mW for listen, and 0.003 mWfor sleep.

Algorithm 1: Sleep/Wake-Up Scheduling of a Node**1** Let ξ and δ be the learning rates and γ be the discountfactor;

2 For each action, initialise value function Q to 0 andpolicy π to 1*n*, where *n* is the number of available actions;

3 repeat

4 select an action *a*in current state *s*based on policy$\pi(s, a)$;

5 if *the selected action a is transmit* **then**

6 the node determines when to transmit the packetin the time slot; /* ref **Algorithm 2** */

7 observe payoff *p* and next state *s_*, update *Q*-value$Q(s, a) \leftarrow (1 - \xi)Q(s, a) + \xi(p + \gamma\ maxa_Q(s_, a_))$;

8 if *the selected action a is not sleep* **then**

9 based on the updated *Q*-value, approximate thepolicy of the neighbour that interacted with thenode in the current time slot;

10 based on the approximation, for each action$a \in A$, update the node's policy $\pi(s, a)$;

11 else

12 calculate the average payoff.$P(s) \leftarrow a \in A \pi(s, a)Q(s, a)$;

13 for *each action* $a \in A$**do**

14 $\pi(s, a) \leftarrow \pi(s, a) + \delta(Q(s, a) - .P(s))$;

15 $\pi(s) \leftarrow Normalise(\pi(s))$; /* ref **Algorithm 3** */

16 $\xi \leftarrow kk{+}1 \cdot \xi$;

17 $s \leftarrow s\_$;

18 until *the process is terminated*;

PSO TECHNIQUE

Theory of particle swarm optimization (PSO) has been growing rapidly. PSO has been used by many applications of several problems. The algorithm of PSO emulates from behaviour of animals societies that don't have any leader in their group or swarm, such as bird flocking and fish schooling. Typically, a flock of animals that have no leaders will find food by random, follow one of the members of the group that has the closest position with a food source (potential solution). The flocks achieve their best condition simultaneously through communication among members who already have a better situation. Animal which has a better condition will inform it to its flocks and the others will move simultaneously to that place. This would happen repeatedly until the best conditions or a food source discovered. The process of PSO algorithm in finding optimal values follows the work of this animal society

CONSTRAINED USING PSO ALGORITHM

The following steps are used by the PSO technique to solve the unit commitment Problem

Step 1:

Initialize a population of particles pi and other variables. Each particle is usually generated randomly with in allowable range.

Step 2:

Initialize the parameters such as the size of population, initial and final inertia weight, random velocity of particle, acceleration constant, the max generation, Lagrange's multiplier, etc.

Step 3:

Calculate the fitness of each individual in the population using the fitness function or cost function.

Step 4:

Compare each individual's fitness value with its pbest. The best fitness value among pbest is denoted as g best.

Step 5:

If the evaluation value of each individual is better than the previous p best, the current value is set to be p best. If the best p best is better than pg best the value is set to be pg best.

Step 6:

Modify the λ and α for each equality and Inequality constraint.

Step 7:

Minimize the fitness function using PSO method for the number of units running at that time.

Step 8:

If the number of iteration reaches the maximum then go to step 9. Otherwise go to step 3.

Step 9:

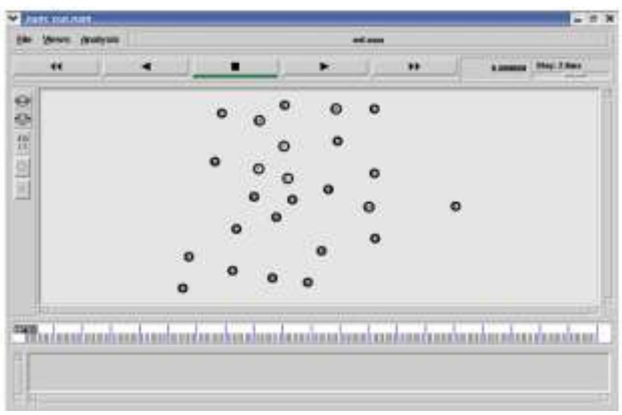
The individual that generates the latest is the optimal generation power of each unit with the minimum total generation cost.

RESULT AND DISCUSSION

5.1. NODE CREATION

In PSO based routing hundred nodes has been created. It shows initial node placement and sink node placement.

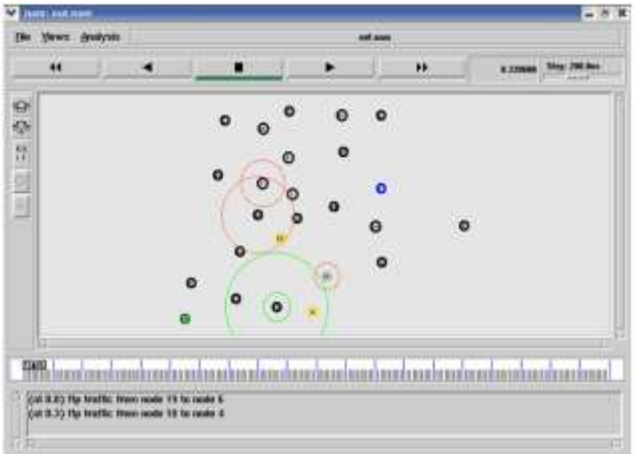
Figure 5.1 Simulation of node creation



5.2 PARTICLE GENERATION

For each iteration random particles are generated and move with Gbest and pbest velocities, for our simulation for each round 20 rounds to be Iterated, the particle generation plotted in x axis with corresponding to routing Cost in y axis.

Fig:5.2.(1) PSO-Particle generation



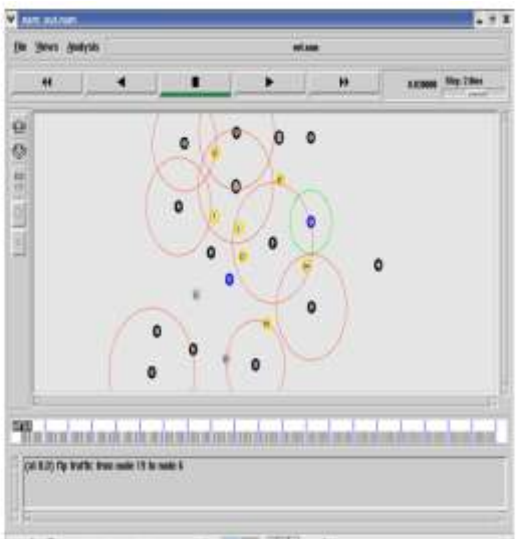


Figure 5.2.(2): PSO-particle generation of nodes

5.3. performance analysis

Number of packets delivered to base station (BS) without dead node in a routing path by proper selection of routing nodes.

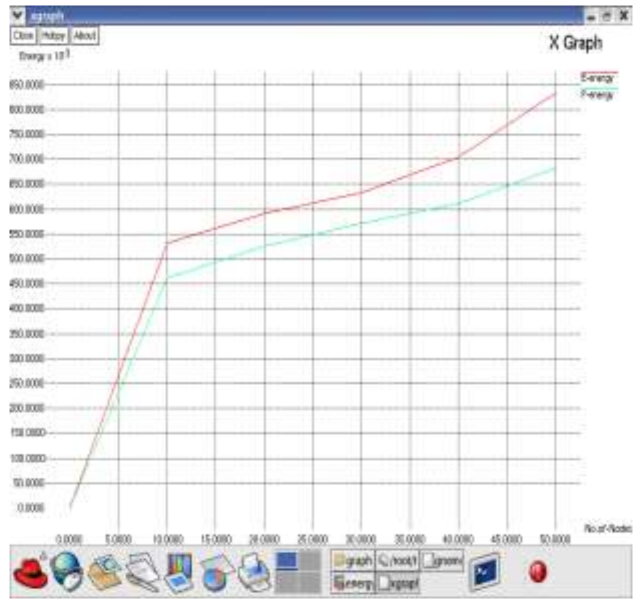


Figure5.3.(1): Energy of the packets

5.4 GRAPH:5.4.1 THROUGHPUT:

Fig: 5.4.(1) throughput of delivered packets

CONCLUSION

This project introduced a PSO (particle swarm optimization) base self-adaptive sleep and wake-up scheduling approach. This approach does not use the technique of duty cycling.Duty cycling is often used to reduce the energy consumption caused by idle listening in Wireless Sensor Networks (WSNs). Most studies on WSNprotocols define a common duty cycle value throughout the network to achieve synchronization among the nodes.

PSO has been a popular technique used to solve optimization problems in WSNs due to its simplicity, high quality of solution, fast convergence, and insignificant computational burden. However, iterative nature of PSO can prohibit its use for high-speed real-time applications, especially if optimization The performance improvement of the proposed approach, compared with existing approaches, may not be big, but the proposed approach provides a new way to study sleep and wake-up scheduling in WSNs.

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