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Distributed Energy-Efficient Algorithm for Wireless Sensor Networks

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Abstract: In this paper, a heterogeneous distributed energy-efficient target supervising protocol for wireless sensor networks have been reported. Here, we have proposed new distributed energy efficient algorithms HADEEPS, based on the scheduling that allow sensor nodes can interchange its state into idle, sleep and active modes. The network lifetime increases with the number of sensors at different sensing range. The simulation results for energy-efficient algorithm, HADEEPS verify that with the adjustable sensing range, heterogeneous nodes, the overall network lifetime improved as compared with existing protocols.

Keywords: Energy-Efficient, Algorithm, Wireless, Sensor, Networks, HADEEPS

I. INTRODUCTION

WSN are distributed systems or a computer network, in which a large number of little and inexpensive devices, sometimes called Motes or sensor nodes that collect environmental data or more recently, medical data. The sense data is collected across the wireless network via multiple hops relaying, aggregated and fed into business applications.

When compared WSNs with traditional ad hoc networks, the most detectable point are that they are limited in memory, power and computational capacities. A node of the WSNs consists of the battery, transceiver, sensing hardware and embedded processor & memory. The primary metric for measuring functioning of WSN protocols is the sensor network lifetime measured by total time during which the network perform its monitoring duties without recharging batteries. Power saving mechanism can be classified into two general ways: adjusting the transmission or sensing range and scheduling the sensor nodes to alternate between active and sleep mode [1, 2, 3, 4].

In this paper, sensor network is consisting of few heterogeneous nodes which are deployed in an effective manner to prolonging the network lifetime. We indicate on the operation of a heterogeneous sensor network with three types of nodes such as normal, advance and super nodes [5, 6, 7]. The remainder of the paper is prepared as follows: In Section 2, we present some related work. In Section 3, we discuss network model. In Section 4, we provide details of distributed algorithms for SNLP and its simulation. We present results and discussion in Section 5. The paper has been concluded in Section 6.

II. RELATED WORK

In this section we look the existing approaches to prolonging the lifetime of WSNs. The existing approaches divided into two categories such as centralized and distributed algorithms. In centralized approaches single node has access the entire network information and in the distributed approaches sensor can exchange information with its neighbors with in a fixed ranges.

In [8] the authors introduce energy efficient data structure to represent the monitoring area, efficiently provable good centralized algorithms for sensor monitoring schedule prolonging the total lifetime and a family of efficient distributed protocol with trade-off between communication and monitoring power consumption.

In [3] authors propose reliable distributed algorithms for target-monitoring and using LEACH protocol for data delivery to the base-station as a communication protocol.

M. Cardei at el [2] address the adjustable range set-cover problem, objective of that problem is to finding a maximum number of set covers and ranges for all the targets.

In [1], investigate a problem of maximizing the duration of time for which the network meets its coverage objective. In this a subset of sensors need to be in “sense” or “on” mode at any given time to meet the coverage objective, while others can go into a power conserving “sleep” mode and these active set of sensors is known as a cover.

In [5, 6, 7] we have studied three type of nodes heterogeneity and implemented that node heterogeneity in target-supervising algorithm.

III. NETWORK MODEL

Our network model is similar to the models described in [1, 3, 4, 8]. We assume that sensors are deployed over the monitored region *R* and each sensor knows its IDs, battery power and its own coordinates as well as coordinates of all the covered targets. Each sensor S has its own monitoring targets T where S can collect the information for the target *T* without the help of any other sensor.

IV. HETEROGENEOUS DISTRIBUTED ENERGY EFFICIENT PROTOCOL FOR ADJUSTABLE RANGE SENSING (HADEEPS)

In this section HADEEPS protocol has been characterized for heterogeneity and adjustable range. Sensor nodes networks are divided into three categories of the sensor such as advance nodes, super nodes and normal nodes. In the HADEEPS each sensor at any moment is in one of three states.

a. ***Active state***: the sensor is active and monitors the targets

b. *Idle state*: In idle state sensor listens to other sensors, but does not monitor targets

c. *deciding state*: the sensor monitors targets, but will alter its state to either active or idle state soon

Finally, the network fails if there is a target which is not covered by any sensor.

A. Simulation Setup

For wide range of physical sensor network sizes with varying node densities this simulator is designed. For the simulation purpose, we created a static network of sensors in a 100m x 100m area. The adjustable parameters are:

[a] S, number of sensor nodes. We vary this from 40 to 200.

[b] The initial energy of each sensor node is 2 J.

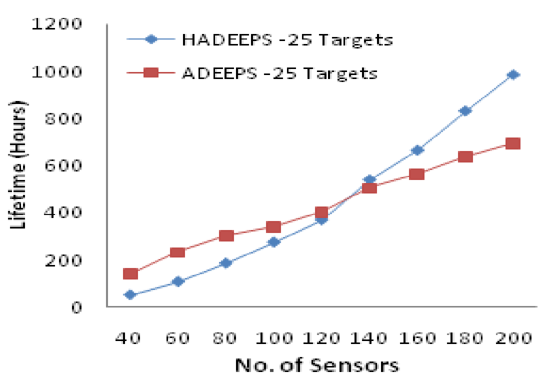
[c] [6],The linear model defined as $ep = c1rp$, where the energy ep needed to cover a target at distance rp , $c1$ is constant and quadratic model is defined as $e_p = c_2 r_p^2$, where $c2$ is a constant. In order to make comparison, we used the same simulations parameters used in [1].

In this paper we defined constants $c1 = E / \left(\sum_{r=1}^{P} rp \right)$ and $c2 = E / \left(\sum_{r=1}^{P} r_p^2 \right)$, Where $E = n * E_0 * (1 + m * (\alpha + m_0 * \beta))$ is the sensor initial energy of the new heterogeneous network in [5, 6, 7]. Consider parameters as $m=0.2$, $m_0=0.5$, $\alpha=2$, $\beta=1$

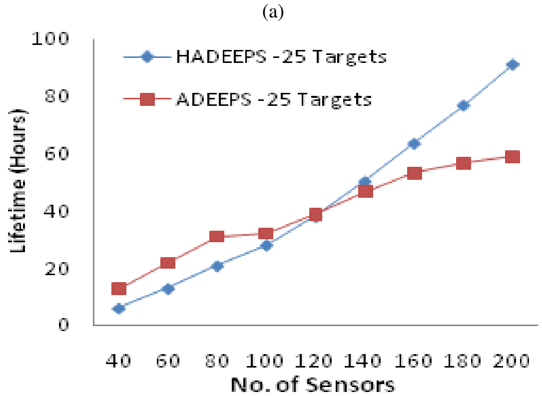
In this paper, Let m be the fraction of the total number of nodes n, and m_o is the percentage of the total number of nodes m which are equipped with β times more energy than the normal nodes, we call these nodes as super nodes.

V. RESULTS AND DISCUSSION

Figure 1 (a&b) indicates the lifetime for sensor nodes in case of linear and quadratic energy model with adjustable sensing range of 50M and targets 25 .



(a)

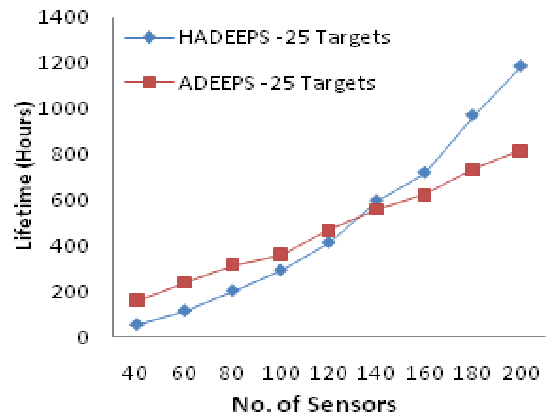


(b)

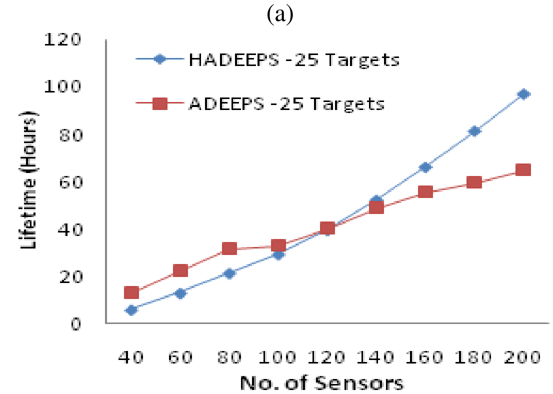
Figure 1 lifetime for sensor networks in case of (a) Linear Energy Model (b) Quadratic Energy Model.

The results have been obtained for modified HADEEPS and their comparison has been reported for lifetime with ADEEPS. It is observed from the results that for 200 numbers of sensors the lifetime obtained is [984, 694] and [91, 58] hours respectively for both energy models at number of targets. In case of linear and quadratic energy model with heterogeneity there is enhancement of [893, 639] hours in lifetime at number of targets.

Figure 2 (a&b) mentioned the lifetime for sensor nodes in case of linear and quadratic energy model with adjustable sensing range of 100M and targets 25.



(a)



(b)

Figure 2 lifetime for sensor networks in case of (a) Linear Energy Model (b) Quadratic Energy Model.

The results have been found for modified HADEEPS and their comparison has been reported for lifetime with ADEEPS. It is seen from the results that for 200 numbers of sensors the lifetime obtained is [1184, 815] and [96, 64] hours respectively for both energy models at number of targets. In case of linear and quadratic energy model with heterogeneity there is enhancement of [1088, 751] hours in lifetime at number of targets.

VI. CONCLUSIONS

In this paper, we have presented a distributed algorithm for increasing the lifetime of WSNs at different sensors. The total lifetime of the sensor network has been reported when all the targets are covered by the sensor cover sets during the simulation. Results have been shown that the overall network lifetime improved with HADEEPS in linear and quadratic energy models.

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