A REVIEW ON USE OF OPTIMIZATION APPROACHES FOR ENERGY EFFICIENT WIRELESS SENSOR NETWORKS

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Abstract - Nowadays, wireless sensor networks (EEWSNs) are widely being utilized in various fields such as internet-of-things, smart grids, military surveillance and health monitoring. The sensing nodes driven with limited energy supplies compelled the research community to propose optimization algorithms to achieve the smooth working of network for the longest achievable time. This paper reviews the implementation of optimization algorithms, heuristics or meta-heuristics, to achieve the energy efficient wireless sensor networks (EEEEWSNs) while fulfilling some constraints such as full coverage of all targets or whole area.

Keywords - Wireless sensor networks, Energy efficiency, Heuristics, Meta-heuristics

I. INTRODUCTION

The excel of technology in every discipline of life has digitized the everyday object. This is due to the fact that information in digital form is easy for storage, processing, transmission and reception compared to analog information. For efficient processing, high quantity of data is needed. The collection of data from different appliances is much important issue for different companies. Mostly data collection is much expensive and lengthy process. Users always wanted to search for the inexpensive, small and energy efficient devices for collection of information for their use. A best solution for collection of different types of physical quantities is Wireless sensor network (EEWSN). The EEWSN is utilized to sense temperature, monitor humidity, house security, medical care and defense scenarios [1]–[7].

It is expected that EEWSN have variety of application because of tiny size, portable deployment, cheap price and communication capability. But the computational power, processing memory and storage unit of these sensing nodes are very low [1]. The other bottleneck with the sensing nodes is their non-rechargeable batteries. Which causes their energy limited and hence life span is finite. These types of issues opened the direction to optimize the energy in EEWSN and propose efficient solutions for maximizing lifetime and coverage. Different optimization problems like deployment of sensors [8], bottlenecks in routing [9], issues in clustering [10] are focused in EEWSN. Furthermore, the coverage problem, connectivity and availability of nodes can be brought together to get better performance and lifetime of network [11].

This paper will give discuss the lifetime problems in EEWSNs and will review different heuristic and meta-heuristics algorithms to solve this problem.

II. USE OF HEURISTICS

The work in [12], suggested the dual flow augmenting heuristic algorithms FR (flow redirection) and least remaining energy path (LREP).Beginning with first viable information routing plan, these two approaches try to keep equity in flow from target to destination paths. The equity mechanism calculates length of the path and algorithm modify the flow from lengthy path to shortest path. FR scheme shows length of path as the least life span of sensing nodes on a track. The LREP elaborates that as least inverse residual energy in sensors with specific path. FR scheme give solutions which has approximately 95% optimal objectives and LREP scheme gives a ratio of 96%.

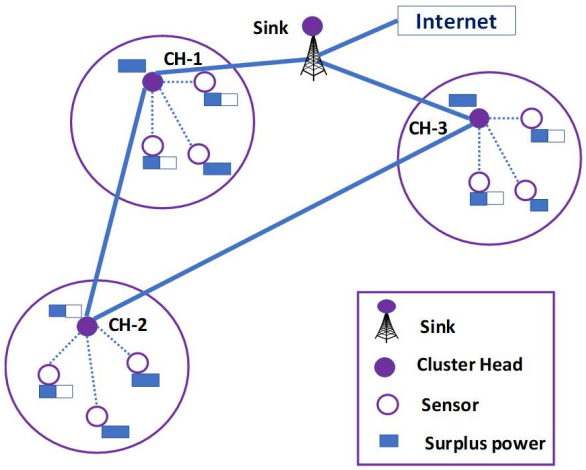


Figure 1: An illustration of EEWSN

An online heuristic algorithm was proposed in [13] which refrain transmission of data transmission from sensors having low energy and also selects paths having least total energy. This also represents the remaining energy fraction of edge. This Heuristics judge the path's quality on the bases of minimum residual energy fraction edge on certain path. The objective of this technique was to select the path having high quality. Keeping the constraint that

energy level should not exceed certain threshold value.

This scheme initially uses Dijkstra's algorithm for finding the least energy track also calculates the minimal remaining energy fraction between all edges on certain path. Following this scheme eliminates complete edges depending on the residual energy fraction no exceeding more than threshold. It selects the path from graph and chooses a least energy path. If consumed energy exceeds the least energy track or in case no track prevails,routing of data call is forwarded on most recent low energy path in last iteration. This work needs a strong centralized coordination, which is very difficult for implementation when we have large networks. To answer this need a hierarchical zone based scheme to employ this technique in smaller sensor zones was given.

The online maximum lifetime (OML) heuristic was proposed by the work [14]. In this technique residual energy of edge is considered. First this scheme cut network of all edges needing much energy for transmission than available energy. Then a least energy path is measured in resulting network. After that all minimal residual energy (minRE) is calculated for all edges on a certain path. In last the authors allocate a value to every leftover edge through a weight function. Wight function allocates a comparatively large weight to every edge. This allocation will decrease energy level of certain sensors below a minimum threshold value. The minimum weight path is then selected by author and transmission of data routing request is done. Distributed version of OML algorithm which bifurcate the sensors in to cluster head. This OML scheme gives a higher average lifetime than the scheme proposed [13] and [15]

III. USE OF META-HEURISTICS

The optimization based on metaheuristics algorithms are discussed in this section. It should be noted before going to further discussion, the metaheuristics algorithms works on transition operators, evaluation operators and determination operators to predict desired solution in solution space [16]. Metaheuristic algorithm have many application in different domains. Different meta heuristic schemes are discussed.

Single Solution based algorithm (SSBA)	Population based Algorithm (PBA)
SA [17]	GA [19]
TS [18]	ACO [20]
	PSO [21]
	HSA [22]

Table 1: Meta-heuristic approaches

The main purpose of this paragraph is to discuss considerations, problems, restriction issues and implementation bottlenecks in metaheuristic schemes. To be more precise, these algorithms also have some research issue like heuristic algorithms. Based on that these schemes are categorized in three categories.

1. Algorithms based on Single Solution.
2. Evolutionary Algorithms.
3. Swarm Intelligence.

The single solutions based algorithms are simulated annealing (SA) and tabu search (TS). These are basic single solution metaheuristics algorithms used forEEWSN. These SA algorithms [23-25] and TS algorithms [26-28] are used for the extension of life span of EEWSN.

SA also challenge the issue of least search diversity at every iteration, when so ever it is used for lifetime problem. That is reason Wang et al. [24] attempted to integrate SA with PSO (other kind of metaheuristic scheme) for showing advanced results.

A problem which shows how to find "good locations" in deployed EEWSN. This is resolved by set k-cover problem, to find the best partitions or subsets or sensors for which GA [29-32] are used.For selecting best routing of paths to transfer information from one sensor to other is main issue of data routing problem in EEWSN. In addition to SA [17] and GA [19, 29-32], many approaches utilize ACO based schemes [33-35]. This is due to original design of Ant colony optimization. It helps us for finding the smallest path for ant routing.

CONCLUSION

In this paper, we review the studies on applying heuristics and metaheuristic algorithms to achieve the energy efficient wireless sensor networks.

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