



Analogy of Traditional and Modern Optimization Techniques in Wireless Sensor Networks: A Review

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Abstract: WSN'S have gained their popularity slowly and steadily since decades now because of their marvelous functionality and extreme conditions they work in. All of these became possible with the efficient usage of algorithms and protocols for their designing. Because of the inventions of so many designing algorithms and protocols in past few decades for WSN's it has become very important to choose the best of all hence calls for the concept called "optimization". Optimization is the action of making the best or most effective use of a situation or resource .In this paper we have discussed about the concept itself ,it's traditional approaches and it's modern approaches as well with main emphasis on one of its most appealing method called as "meta heuristic".

Keywords: WSN, cluster, Traditional methods, Optimization, Heuristic, Meta-heuristic.

I. INTRODUCTION

Wireless sensor networks are the mostly used networks today and have been around since couple of decades now, the reason behind their popularity is their compact and simple architecture along with that the extreme conditions where they work without any human intervention. and were initially designed in 1950's for the monitoring of military areas. Though WSN has various features and challenges in its development, most important one is its energy efficient nature. Out of the three architectural designs distributed, hierarchical and clustered the clustered is the most efficient design for WSN [3].

WSN has many active areas where proper work needs to be done some of them are routing ,data management, topology control, power issues, coverage and many more[7]. To deal with all these areas there are many algorithms and protocols designed separately for each area and to choose the best for the development of WSN optimization needs to be done .in rest of the paper entire emphasis is laid on this concept.

Optimization is a branch of mathematics and computational science that studies methods and techniques specially designed for finding the "best" solution of a given optimized problem or simply we can say that the action of making the best or most effective use of a situation or resource . The concept of optimization was first introduced around 40's and since then the concept has given infinite optimized results in various fields.

Given optimization has its branches almost in every field but and also has problems related to it, same is the case with WSN. Optimization problems related to WSN constitute of coverage, topology control, scheduling, mobility, routing and more[8]. Optimization techniques generally falls into two categories - traditional and modern but we will focus on the latter one.

Given below is the classification of optimization methods. Part II of the paper gives a briefing about traditional methods and its limitations then part III discusses about the various modern techniques used, with comparisons part IV gives the literature survey and part V concludes the paper.

II. TRADITIONAL METHODS

Traditional methods also known as 'conventional methods' or 'classic methods' were the one used before modern techniques but are also used today with enhancements added to them like gradient method. Mostly used techniques are linear programming, non-linear programming, quadratic programming and more. Non-linear type has further more types we will not go deep into that.

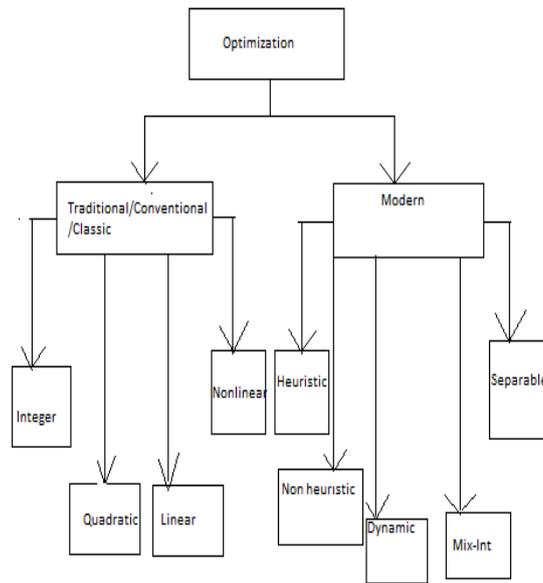


FIG-1: Classification of optimization techniques

Traditional methods were mostly used for optimization in limited areas according to the type of environment and application. No of variables and constraints needed to be adjusted during implementation and this proved to be a great drawback for these methods, other problems were the risk of divergence, numerical difficulties during computing and hence made the room for ‘modern optimization techniques.’

III. MODERN METHODS

Recently the advances in computer engineering and the increased complexity of the power system optimization problem have led to a greater need for application specialized programming techniques for large-scale problems. These include dynamic programming, Lagrange multiplier methods, **heuristic techniques, meta-heuristic techniques**, in this section we lay emphasis on the last two. Both techniques were proposed in early 1970’s. **Heuristic method** is yet another optimization method able to determine not a perfectly accurate solution but a set of good quality approximations to exact solution.

Meta-heuristic came after heuristic hence prefix added to it “meta”. Unlike exact methods meta heuristic methods have a simple and compact theoretical support ,being often based on criteria of empirical nature(factual) .Out of the two, meta heuristic has gained more importance ,the reason behind is given through comparison between heuristic and meta heuristic.

TABLE 1: Comparison between heuristic and Meta heuristic method

Heuristic	Meta- heuristic
Heuristic get stuck in local optima	Meta heuristic have mechanism to avoid that
Heuristic methods are problem specific methods	Meta heuristic are problem independent methods and can be applied to wide range
Heuristic is a non-exact method but gives very close solution	So is meta heuristic

There are various types of Meta heuristics methods some of them are: **evolutionary computation techniques (Genetic algorithm, differential evolution), particle swarm optimization (honey bee colony or artificial bee colony algorithm, ant colony), tabu search and more.**

IV. LITERATURE REVIEW

Ahmad Abed Alhameed et al [3] explored the WSN architecture according to the OSI model with some protocols in order to achieve good background on the wireless sensor networks and helped readers to find a summary for ideas, protocols and problems towards an appropriate design model for WSN.



Sukhwinder Sharma et al [7] in the paper gave an overview of the broad research issues and challenges involved in the design of WSNs are presented. Energy conservation emerges as one the most critical aspect in hardware and software related design issues, and puts a question mark on the overall practicability of WSNs. Besides, other related main issues include specialized hardware, software and operating system, synchronization, QoS, security, architecture and data collection related aspects with minimum communication and computation costs

Priyanka Sharma et al [10] discussed the routing protocols based on path establishment network structure and protocol operation. The routing protocols belonging to path establishment can be further classified as proactive, reactive and hybrid. The routing protocols belonging to network structure can be further classified as data centric/attribute based, hierarchical and location based. The routing protocols belonging to protocol operation can be further classified as query, bio-inspired, negotiation, coherent, non coherent, QoS, multipath and mobility.

Dervis Karaboga et al[2] a novel hierarchical clustering approach for wireless sensor networks to maintain energy depletion of the network in minimum using Artificial Bee Colony Algorithm which is a new swarm based heuristic algorithm. They present a protocol using Artificial Bee Colony Algorithm, which tries to provide optimum cluster organization in order to minimize energy consumption. In cluster based networks, the selection of cluster heads and its members is an essential process which affects energy consumption. Simulation results demonstrate that the proposed approach provides promising solutions for the wireless sensor networks.

Christian Blum [1] in his paper discussed ant colony optimization, its origin and implemented it with beam search, AI, OR as hybridization.

Richa Bajaj et al [11] discussed ant colony optimization and used it for solving travelling salesman problem which lies under NP hard problems

Ada Gogu et al [8] discussed about the various optimization problems faced during design of a wireless sensor network. Problems he discussed were mobility problems as when sensors are moving or changing their positions, topology, coverage and many more.

Lovneet Kaur et al [9] discussed about the bio inspired or nature inspired algorithms and their use for optimizing routing in wireless sensor networks .They briefly discussed ant colony optimization, artificial bee colony algorithm and particle swarm optimization.

Parul Khurana et al [4] introduced that Sensor network routing has gained large attention in the recent years. In comparison to traditional data routing in wired networks it has introduced unique challenges. This paper presents a comprehensive survey of the routing techniques for WSNs from the recent work. The main categories explored in this paper are bio-inspired routing protocols, QoS, hierarchical based and location-based routing.

N.M Abdul et al [12] explained that Energy efficiency is one of the apparent challenges facing WSNs which has impacted immensely on the network performance. Hence, clustering protocols that eliminate energy inefficiencies in the network is essential. As finding an optimal set of cluster heads is an NP-hard problem, the application of heuristic algorithm is required to produce good clustering.

In this paper, they proposed a clustering solution for WSNs using a hybrid algorithm based on Backtracking Search Optimization Algorithm (BSA) and K-Means. A fitness function that incorporates aspects such as expected energy consumption in the network and maximum intra-cluster distance is utilized to address the problem of energy efficiency. Performance comparison against well-known clustering protocols such as LEACH and LEACH-C reveals that the hybrid of BSA and K-Means clustering algorithm is able to deliver more data to the base station and extends the network lifetime.

V CONCLUSION

Wireless sensor network (WSN) can be defined as a collection of physically dispersed and purposeful sensing elements for keeping an eye and recording the physical conditions of the environment and composing the gathered data at the main location. In this paper we discussed WSN'S features, challenges, applications and the best WSN that is "cluster WSN". Each and every system or more precisely if we say any automatic system is developed to achieve only one goal that is 'maximum output in least cost' and same is the case with WSN. To reach this goal WSN uses various protocols, algorithms. And to bring out best of all the algorithms the 'concept of optimization' is used which made the basis of this paper .Out of the two types of optimization techniques mentioned 'meta heuristic' is the one which has



broader aspect and constitutes of various algorithms which can be used in future to optimize various areas of cluster based WSN like power consumption, coverage problems, routing and many more.

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