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Abstract

This paper presents a novel technique for islanding detection using machine learning. Islanding occurs when a distribution generation (DG) along with local load become electrically isolated from the grid. Existing methodologies lack in accuracy and speed of islanding detection. The proposed methodology involves the simulation of distribution system with DG, creation of islanding, and non-islanding cases to capture voltages and current data which will be further processed using a four-level discrete wavelet transform for feature extraction. The machine learning classification model is created using a supervised learning classification algorithm based on the dataset generated. This classification model is used to detect the islanding condition. The proposed system is tested on different islanding and non-Islanding conditions. The experimental result shows that the proposed methodology is efficient than earlier islanding detection techniques.

Keywords

Islanding Machine learning Classifier Distributed generation Support vector machine K-nearest neighbor

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Design and Control of Capacitor-Supported Dynamic Voltage Restorer for Mitigation of Power Quality Disturbances

Mohan Tasre, Gajanan Dhole, Saurabh Jadhao, and Rajesh Sharma

Abstract Voltage sag contributes majorly in the stalling industrial processes which further incur the economic loss. The dynamic voltage restorer has emerged as an efficient technology for sag mitigation. The capacitor-supported dynamic voltage restorer is the cost-effective solution that mitigates sag problem. This work describes the capacitor-supported DVR architecture along with analysis of its compensation technique mathematically. Further, the simplified methodology adopted for specification determination of major components is explained. The time-domain control algorithm with required transformations is explained. The adopted design and control strategy of is justified by observing DVR performance with ideal and practical power system conditions.

Keywords Point of common coupling · Voltage sag · Total harmonic distortion · Voltage unbalance factor

1 Introduction

Engineering researches have modernized the generation, transmission as well as distribution sectors of power system. At distribution level, the distribution feeder is under shear stress due to varied load connected on them. Similarly, at consumer end, electrical load employed for industrial, commercial, and domestic sectors undergone

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Improved Control Strategy for Harmonic Mitigation in Multilevel Inverter

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Abstract- **In multilevel inverters, obtaining solution to the selective harmonic elimination equation is really difficult and time consuming. Secondly, finding global optimum solution is also challenging. In this paper, new improved proposed optimization algorithm is presented. As Compared to other optimization algorithms, it will enhance the computational speed and chances for finding global solution will be more. Also it will escape the solution from stucking into local optima. This proposed algorithm mainly targets at adaptive adjustment control of pheromone and updation of active evaporation factor. In this, pheromone deposition factor and ant's movement is improved and making it convenient for solving large scale problems. Hence this proposed algorithm is applied for solving nonlinear transcendental equation which not only provides the optimized solution for switching angles but it will reduce the lower order harmonics and THD also. The various simulated and experimental results shown in the paper proves the effectiveness of proposed algorithm for finding the global optimum solution with high convergence speed.**

Keywords- ***Adaptive control pheromone; Ant colony optimization; Active evaporation factor; Selective harmonic elimination; Multilevel Inverter; Total harmonic distortion.***

I. INTRODUCTION

The ACO algorithm with its several advantages is widely used in solving many combinatorial optimization problems. It has positive feedback for obtaining rapid solution, dynamic applications, metahuristics search characteristics, robustness, Inherent parallelism implementation etc. Hence gradually it becomes the emerging field in solving optimization algorithms [1]-[3]. First it was used in problem of quadratic assignment [4], problem of job scheduling [5], to solve traveling salesman problem [6] and so on. Inspite of many advantages, it has shortcomings too i.e., maximum searching time, very slow speed of convergence, premature convergence for complex problems and so on. Many researchers proposed improved ACO algorithms to overcome these shortages. ACO with active pheromone updation and cell scheduling is proposed by Leng et al. for flexible manufacturing process to reduce cost and time [7]. Yang and Lai proposed improved ACO for p//T (p//T-ACO) for solving practical large scale problems [8]. Xu et al. suggested chaotic map for hybrid algorithm for enhancement of basic the ACO algorithm and to solve VRP problems [9]. Combination of ant colony algorithm with particle swarm algorithm is applied to solve traveling salesman problem (TSP) by Walid et al.[10]. Extended ant colony algorithm to implement regulation policy for controlling each type of ant during search process is presented by Escario et al.[11]. New GACO ant colony algorithm to compute Unified Device Architecture is presented by Li and Jin [12]. This paper presents, improved new ant colony optimization (NEWACO) algorithm which is an efficient and intelligent algorithm applied to solve nonlinear selective harmonic elimination equations which are transcendental in nature to obtain the optimized solution for switching angles in single phase H-Bridge 7 level multilevel inverter. With these solutions, Total Harmonic Distortion (THD) will also reduce to a great extent which proves the effectiveness of proposed algorithm.

II. Formulation of SHE Equations

Fig.1 shows bipolar output voltage waveform in inverters. From Fourier series, the output voltage equation can be obtained and is by equation (1). This equation is a nonlinear transcendental equation which contains trigonometric terms given by

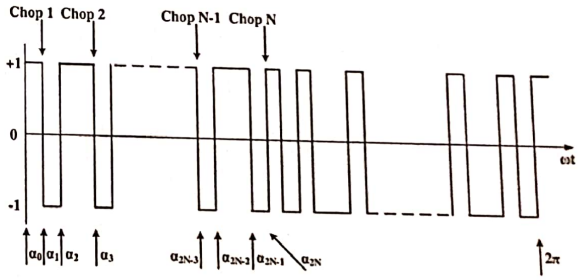

Fig. 1 Bipolar Output voltage waveform

$$V_{2k+1} = \frac{4V_{dc}}{(2k+1)\pi} \sum_{i=0}^{N} \cos(2k+1)\alpha_i \qquad (1)$$

Where, V = Inverter output voltage

V_{dc} = Input voltage magnitude

α = Switching angles

N = Harmonic equations

k = Number of switching angles (from 0 to N-1)

Total number of harmonic equations (N) can be given by

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Preface

We hereby are delighted to announce that Shaheed Sukhdev College of Business Studies, New Delhi, in association with National Institute of Technology Patna and the University of Valladolid, Spain, has hosted the eagerly awaited and much-coveted Recent Studies on Computational Intelligence: Doctoral Symposium on Computational Intelligence (DoSCI 2020). The first version of the symposium was able to attract a diverse range of engineering practitioners, academicians, scholars and industry delegates, with the reception of abstracts including more than 143 authors from different parts of the world. The committee of professionals dedicated towards the symposium is striving to achieve high-quality technical chapters with tracks on computational intelligence. The track chosen in the symposium is very famous among present-day research community. Therefore, a lot of research is happening in the above-mentioned research field and their related sub-fields. The symposium has targeted out-of-box ideas, methodologies, applications, expositions, surveys and presentations helping to upgrade the current status of research. More than 40 full-length papers have been received, among which the contributions are focused on theoretical, computer simulation-based research and laboratory-scale experiments. Among these manuscripts, nine papers have been included in the Springer Books after a thorough two-stage review and editing process. All the manuscripts submitted were peer-reviewed by at least two independent reviewers, who were provided with a detailed review proforma. The comments from the reviewers were communicated to the authors, who incorporated the suggestions in their revised manuscripts. The recommendations from two reviewers were taken into consideration while selecting a manuscript for inclusion in the proceedings. The exhaustiveness of the review process is evident, given the large number of articles received addressing a wide range of research areas. The stringent review process ensured that each published manuscript met the rigorous academic and scientific standards. It is an exalting experience to finally see these elite contributions materialize into Recent Studies on Computational Intelligence: Doctoral Symposium on Computational Intelligence (DoSCI 2020) by Springer.

DoSCI 2020 invited six keynote speakers, who are eminent researchers in the field of computer science and engineering, from different parts of the world. In addition to the plenary sessions on each day of the conference, 15 concurrent technical sessions are held every day to assure the oral presentation of around nine accepted papers. Keynote speakers and session chair(s) for the session are leading researchers from the thematic area of the session.

DoSCI 2020 of such magnitude and release proceedings by Springer has been the remarkable outcome of the untiring efforts of the entire organizing team. The success of an event undoubtedly involves the painstaking efforts of several contributors at different stages, dictated by their devotion and sincerity. Fortunately, since the beginning of its journey, DoSCI 2020 has received support and contributions from every corner. We thank them all who have wished the best for DoSCI 2020 and contributed by any means towards its success. The edited proceedings volume by Springer would not have been possible without the perseverance of all the steering, advisory and technical program committee members.

All the contributing authors owe thanks from the organizers of DoSCI 2020 for their interest and exceptional articles. We would also like to thank the authors of the papers for adhering to the time schedule and for incorporating the review comments. We wish to extend my heartfelt acknowledgment to the authors, peer reviewers, committee members and production staff whose diligent work put shape to the DoSCI 2020 proceedings. We especially want to thank our dedicated team of peer reviewers who volunteered for the arduous and tedious step of quality checking and critique on the submitted manuscripts. The management, faculties, administrative and support staff of the college have always been extending their services whenever needed, for which we remain thankful to them.

Lastly, we would like to thank Springer for accepting our proposal for publishing the DoSCI 2020 proceedings. Help received from Mr. Aninda Bose, the acquisition senior editor, in the process has been very useful.

New Delhi, India

Ashish Khanna
Deepak Gupta
Organizers, ICICC 2020

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Optimizing Cost and Maximizing Profit for Multi-Cloud-Based Big Data Computing by Deadline-Aware Optimize Resource Allocation

Amitkumar Manekar and G. Pradeepini

Abstract Cloud computing is most powerful and demanding for businesses in this decade. "Data is future oil" can be proved in many ways, as most of the business and corporate giants are very much worried about business data. In fact to accommodate and process this data, we required a very expensive platform that can work efficiently. Researchers and many professionals have been proved and standardize some cloud computing standards. But still, some modifications and major research toward big data processing in multi-cloud infrastructure need to investigate. Reliance on a single cloud provider is a challenging task with respect to services like latency, QoS and non-affordable monetary cost to application providers. We proposed an effective deadline-aware resource management scheme through novel algorithms, namely job tracking, resource estimation and resource allocation. In this paper, we will discuss two algorithms in detail and do an experiment in a multi-cloud environment. Firstly, we check job track algorithms and at last, we will check job estimation algorithms. Utilization of multiple cloud service providers is a promising solution for an affordable class of services and QoS.

Keywords BDA · Resource allocator · Cloud computing · Optimization · Fare share · Cost optimization

1 Introduction

The last decade was a "data decade." Many multi-national company changes its modes of operation based on data analysis. Big data and data analysis is an essential and mandate for every industry. Companies like Amazon, Google and Microsoft are ready with their data processing platform completely based on the cloud [1] in other

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sense, all social media companies are also targeting cloud as a prominent solution. Netflix and YouTube have already started using the cloud [2]. Cloud computing impacted and proved as a very effective and reliable solution for multivariate huge data. Still, researchers and professionals are working to enhance more and more possibilities from the existing cloud structure. One of the major and critical tasks is resource provisioning in a multi-cloud architecture. We tried to solve some of the issues in multi-cloud architecture by implementing a prominent algorithm in a multi-cloud architecture. Cloud computing is available in three types for each of us [3], ***the foremost Publics Cloud Platform*** in which third-party providers are responsible to provide services on the public cloud. In most cases, these services are maybe free or sold by service providers on-demand, sometimes customers have to pay only per usage for the CPU cycles, storage or bandwidth they consume for their applications [4–6]. ***Second is the Private Cloud Platform*** in this entire infrastructure is privately owned by the organization; also it completely maintained and manages via internal resources. For any organization, it is very difficult to maintain and manage the entire infrastructure then, they can own ***VPC (Virtual Private Cloud)*** where a third-party cloud provider-owned infrastructure but used under organization premises [7–9]. ***The third is the Hybrid Cloud Platform***; as the name indicated, it is a mixed computing resource from public and private services. This platform is rapidly used by many as a cost-saving and readily available on demand for fast-moving digital business transformation. Cloud providers enhanced their infrastructure in distributed by expanding data centers in different geographical regions worldwide [4–6]. Google itself operates 13 data centers around the globe. Managing distributed data centers and maximizing profit is a current problem. Ultimately, the customer is affected by high cost and maintenance charges by these data centers. This cost has four principles bound by applications serving to big data. Numerous cost-effective parallel and time-effective tools are available in big data processing with the programming paradigm. The master player in this tool or every big data application is the management of resource which use an available resource and manage trade-offs between cost and result. Complexity, scale, heterogeneity and hard predictability are the key factors of these big data platforms. All challenges like complexity, which exactly in inner of architecture, consist of proper scheduling of resources, managing power, storage system and many more. The scale totally depends on target problem—data dimensions and parallelism with high deadline [10]. Heterogeneity is a technology need—maintainability and evolving nature of the hardware. Hard predictability is nothing but the crunching of these their major factors explained earlier as well as a combined effect of hardware trade-offs.

2 Literature Survey and Gap Identification

Inacio, E. C., Dantas in 2014 specified characterization [11] which deals with optimization problems related to large dataset has mentioned the scale exacerbates. A variety of aspects have an effect on the feat of scheduling policies such as data volume

(storage), data variety, data velocity, security and privacy, cost, connectivity and data sharing [12, 13]. The resource manager can be organized in a two-layer architecture as shown in Fig. 1. The job scheduler [12] is responsible for allocating resources to mitigate the execution of various different jobs running at the same time.

Figure 1 represents the local executable resource scale which exacerbates known management and dimensioning problems, both in relation to architecture and resource allocation and coordination [14, 15]. The task-level scheduler, on the other hand, decides how to assign tasks on multiple task executors for each job [10, 16].

Cluster scheduler measures each job as a black box and executes as a general policy and strategy. Our efforts are that by optimizing fiscally application-specific features, we finally optimize resource scheduling decisions and achieve better performance for advanced data analytics [17].

Figure 2 shows various open-source big data resource management frameworks [18]. In many pieces of literature, it is observed that most of the available big data processing framework is an open-source framework. Some of the preparatory frameworks have license fees and the necessity of specialized high-end infrastructure.

On the contrary, open-source uses commodity hardware with marginal variation and requirements. Basically, Spark is a mainstream data streaming framework which is the industry likely and can be expanded and ultimately used in various IoT-based application data analysis. YARN is the heart of Hadoop which works for global resource management (ResourceManager) and per-application management (Application Master) [19–21].

As far as research gap identification and problem formulation, some observations are mentioned.

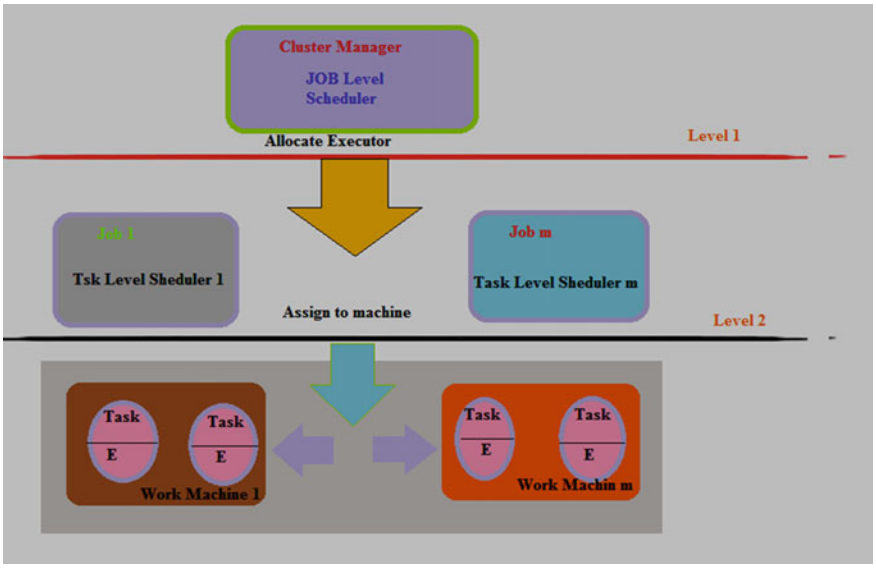

Fig. 1 Hierarchical resource management system

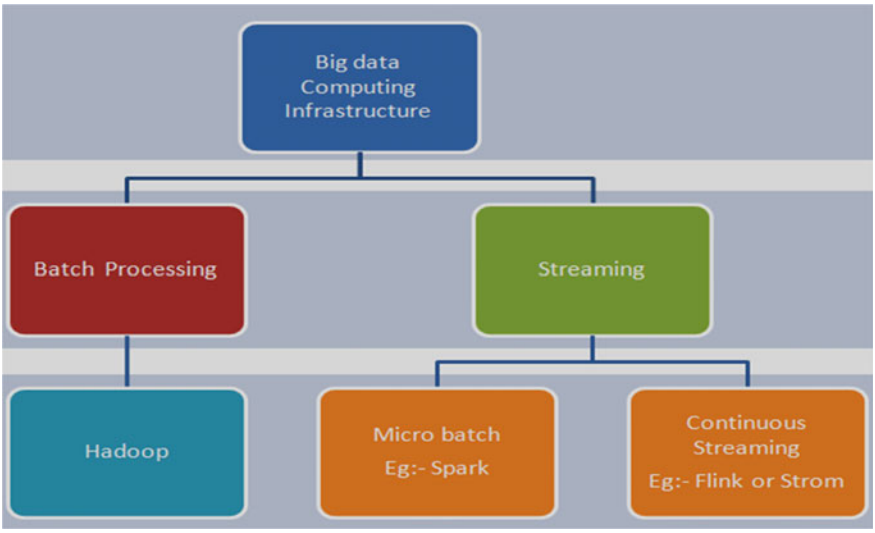

Fig. 2 Classification of big data resource management frameworks

1. Apache Spark with fault tolerance mechanism and characterization to support in data streaming is a prominent platform
2. Spark MLlib and Flink-ML offer a variety of machine learning algorithms and utilities to exploit distributed and scalable big data applications.
3. More and more focus should be made for a few issues such as throughput, latency and machine learning.
4. Deadline-aware job tracing and scheduling resources should be managed instead of the fine-grained splitting of resource pooled when deadlines are not mitigating.
5. Deadline achievement without wasting resources in IoT workloads in a resource-constrained environment.

3 Problem Formulation

Missing a deadline disturbs entire large intensive data processing and leads to under-used resource utilization, incurred the cost of cloud uses for both cloud service provider and user, and leads to poor decision making [22, 23]. To address this issue, we designed a framework that is actually to be framework-agnostic and not rely on job repetition or pre-emption support. On the other side in this work, focus is maintained to utilize job histories and statics to control job admission. Instead of traditional fair share resource utilization, we design a deadline-aware optimized resource allocation policy by implementing two algorithms—one is job tracking and other is resource estimation and resource allocation [8, 24]. Consideration of the second algorithm

based on an only decision is made for effective deadline-aware resource allocation. Let us discuss the actual problem formulation.

To overcome such issues, some research objectives are drawn based on intensive literature review and research gap identification. Our objectives for the formulation of problems are listed below.

1. *Design a policy for improving deadline and fairness in resource allocation by using past workload data and deadline information for the more diverse workload.*
2. *Use the information in objective 1 for estimating the fraction of requested resource for complete job before actually deadline expires with hard and soft deadline scenario.*
3. *Finally, optimize the result for fair share policy for allocating resources while running in fewer or greater resources according to changing workload with strategies for repetition of jobs for allocation in a fair share.*
4. *Comparing the result with YARN resource allocator and demonstrating the purpose of improvement for finding the best possible solution with low cost in terms of cloud providers and users in IoT workload.*

With the above-said research objective by considering certain scenario, a framework of fair share resource allocator has been proposed. In this framework, the goal is to mitigate all objectives one by one. In this section, two algorithms are proposed to fulfill these objectives. A first algorithm is job tracking algorithm, and the second is job estimation algorithms. The proposed algorithm is constructed by keeping a view on fair share and deadline-aware allocation with admission control by resource negotiation. Our approach is to negotiating CPU and other commodity resources for a job execution to meet deadlines in a resource-constrained environment.

To execute a newly arrived job, the note should be taken for execution time data for previous jobs. Analyzing each job estimation can be drawn for a minimum number of CPUs that the job would have needed and deadline awareness, this can be noted as $\mathrm{CPU}_{\mathrm{Deadline}}$. $\mathrm{CPU}_{\mathrm{Deadline}}$ can be calculated on the basis of the fraction of devising the compute time of job and deadline gave ($\mathrm{CPU}_{\mathrm{Deadline}} = \mathrm{C}_{\mathrm{time}}/deadline$). Maximum number of CPUs can be assigned to any job (*Mcpus*). Algorithm 1 describe Job_Tracking algorithms to calculate the deadline and estimate a minimum number of CPU.

Algorithm—Job track algorithms and resource allocation system based on Apache Spark—For the execution of algorithm, an application is to be submitted to Spark Cluster with desired RSA w.r.t possible resources computing like (CPU), Memory (M) and total executors (Ex) per application. Prior knowledge of the total resource amount of cluster need is essential.

A. In Apache Spark master and worker, nodes are being deployed on cloud virtual machines. Assume that these virtual machines (VM's) are homogenously used in extension assumption made about all virtual machines that have the same computation power, i.e., same CPU (cores), storage and computational memory [25].

Algorithm 1 Job_Tracking	
1	*Initiation of* A_{sp}
2	*Accept Fun Job_Track(* C_{time}, R_{Task}, *D,* N_{cpu}*Allo, R)*
3	$CPU_{Deadline} = C_{time}/D$
4	$M_{Cpus} = min(Req_{Task}, CC)$
5	$Req_{MinRate} = CPU_{Deadline}/Max_{CPU}$
6	$Req_{minList}$*. add(ReqMinRate)v*
7	$CPU_{Frac}Min = min(ReqminList)$
8	$CPU_{Frac}Max = max(ReqminList)$
9	$CPU_{Frac}Last = NcpuAllo/CPUFracMax$
10	*Success_Last = Success*
11	*Function Ends*

Algorithm 1—*Job Estimation based on Apache Spark*—For the execution of algorithm, an application is to be submitted to Spark Cluster with desired RSA w.r.t possible resources computing like (CPU), memory (*M*) and total executors (Ex) per application. The algorithm mentioned specified fair resource allocation system (*FRAS*) based on Apache Spark. Prior knowledge of the total resource amount of cluster need is essential. From Algorithm 1, use analyzed data for each completed job which previously executed to finish the job who meets their deadline with maximum parallelism; Stratos Dimopoulos [18] mentioned name *Justice*—for their algorithms. In this paper, we tried to implement in the same way as mentioned in [26] with modification with respective our objective is drawn earlier in this section. This algorithm admits all jobs as in condition for bootstrapping the system. Fair share resource allocator first.

Algorithm 2 Job_Estimation algorithms	
1	*Initiation of* A_{sp}
2	*Accept Fun Job_Track(*C_{time}, R_{Task}, *D,* N_{cpu}*Allo, R)*
3	$CPU_{Deadline} = C_{time}/D$
4	$M_{Cpus} = min(Req_{Task}, CC)$
5	$Req_{MinRate} = CPU_{Deadline}/Max_{CPU}$
6	*If* $Req_{MinRate} > CPUFrac$ *then*
7	$CPU_{Frac} = Req_{MinRate}$
8	*End IF*
9	*Function Ends*

4 Static and Dynamic Performance Analysis

We proposed a novel algorithm for the resource-constrained environment with a deadline for resource-constrained cluster capacities (number of CPUs). The static and dynamic performance analysis of these algorithms will be evaluated on certain parameters. We are very hopeful for the performance analysis after experimenting on fairness evaluation, deadline satisfaction, efficient resource usage and cluster utilization. Basically, all these parameters will be very helpful for enhancing the static and dynamic stability of a multi-cloud environment of resources provided by the various cloud service providers. Multi-cloud environment basically provided by a various service provider may or may not be situated with the same geographical area and also may not be performed hypothetically same. A proposed set of the algorithm is statistically evaluated on a said parameter by using simulation developed in Java and Python overfit the different BDA analysis tools. The proposed set of algorithm address problem related to fairness evaluation, deadline satisfaction, efficient resource usage, and cluster utilization and facilitate appropriate selection and management. Ultimately, the cost of data-intensive applications is minimized, while the specified QoS by users is met. Discussion of expected result on the basis of these algorithms is mentioned following.

A. ***Fairness Evaluation***—Fair share mechanisms can violate fairness in certain conditions like when CPU demands exceed with respective available. Fairness violations happen because future workload prediction is complicated and not anticipated by this kind of mechanism. A job with high resource demand is not to get resources and dropped from execution. Usually, jobs waiting in the queue can miss the deadline due to a heavy workload. Proposed algorithms will mitigate this kind of problem with fair share resource allocation with deadline awareness in a resource-constrained environment.
B. ***Deadline Satisfaction***—Admission control mechanism is very important in this parameter. Without admission control, admit jobs cannot meet the deadline. Ultimately, unnecessary queuing of jobs and resource congestion may lead to the dropping of jobs from the execution queue. The proposed algorithm is trained to achieve a larger fraction of deadline successes overall.
C. ***Efficient Resource Usage***—For a fixed workload resource scarcity is not a problem; perhaps the proposed algorithm gives a fair chance to get extra resource and probably provision to expand in demands of extra resource in execution. This will be carried out with conservative, prioritizing fairness and deadline success over resource saturation.
D. ***Cluster Utilization***—It is very complicated for the fair share resource allocator without implementing admission control and proper resource utilization technique to enhanced cluster utilization. Hence, a proposed algorithm takes care of implementation and execution of more workload without making CPU too busy by analyzing the duration of idle CPU.

5 Experimental Setup

Existing fair share resource allocator does not take consideration of the deadline of every individual job. The general assumption in this kind of resource allocation is every job has indefinitely and that there is no limit on the turnaround time a job's owner is willing to tolerate. The proposed algorithm will be implemented for the basic allocator by considering the job deadline for the resource-constrained environment. Attempting to a trace-based simulation developed in Python and Java for the admission control while submitting a job will give the desired result. We are in phase to implement this for different resource-constrained with a variety of hardware precisions. For the entire experimental setup, nodes run on Ubuntu 12.04 Linux system with mapped reduce Hadoop stack.

6 Results Obtained and Work in Progress

The proposed algorithm is promising in tracking the success of its allocation decisions and improves its future allocations accordingly. Every time a job completes, it updates a cluster-wide model that includes information about the duration, size, maximum parallelization, deadline and provided resources for each job. If the job is successful, the proposed algorithm is more optimistic providing the jobs that follow with fewer resources hoping they will still meet their deadlines? Next we compare the result of the proposed algorithm with the existing methodology in the big data analytics framework. The novelty of the proposed algorithm is if the job is unsuccessful Justice provides more conservative allocations to make sure no more jobs miss their deadlines.

7 Expected Contribution to the Literature

Our research aims to satisfy deadlines and preserve fairness to enable reliable use of multi-analytic systems in resource-constrained clusters. It achieves this in a framework-agnostic way by utilizing admission control and predicting resource requirements without exploiting job repetitions. A key point of our research is its applicability without costly modifications and maintenance in existing popular open-source systems like Apache Mesos and YARN. Thus it requires minimal effort to integrate with the resource manager without the need to adapt to API or structural changes of the processing engines.

8 Conclusion and Future Work

Modern big data analytics system is designed to very-large-scale and fault-tolerant operation which gives new revaluation to the corporate industry. In every sector of industry whether it is a health care, tourism, bioinformatics education, finance, e-commerce, social networks, sports and much more, fast analysis and strong support of big data analysis are required. The advent of IoT brings the combined operation of big data processing systems in smaller, resource-constrained and shared clusters. With the advancement of cloud-enabled big data, adaptation processing works are assigned with low latency, and fair share resource allocation and deadline optimization are the challenges. We try to mitigate the problem with proposed algorithms in a convincing way which can lead the faster and prominent BDA for various available tools like Hadoop, Spark, etc. Our proposed algorithms are in implementation phase. As future work, a try is on implementation of this work as a lightweight API-based integration module for resource management.

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K. Srujan Raju
Editors

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Preface

The objective of this conference is to provide a forum to experts, researchers and post-graduate students from different disciplines to present problems in several fields of Science, Technology and Engineering such as theoretical and computational aspects in Informatics, Physics, Chemistry, Mechanics, Biology, Economics and other sciences from the entire world in order to discuss high-level scientific questions and exchange solid knowledge of pure and applied sciences and investigate diverse backgrounds theoretically and practically.

The international conference on **Computational and Bio Engineering (CBE'20)** was held in Tirupati, Andhra Pradesh, India, from 4 to 5 December 2020 at Sri Padmavati Mahila Visvavidyalaym (SPMVV) which is a women's university. Tirupati City is situated in southeastern Andhra Pradesh State under Rayalaseema Region in Chittoor District, where Tirupati is considered as a major holy city for Hinduism and receives a significant amount of pilgrimage traffic. It is referred to as the "Spiritual Capital of Andhra Pradesh". Many attractions here are geared towards religious tourisms and another one is Education Hub. And one of the educational universities is SPMVV which was started in 1983 by Sri N. T. Rama Rao, the Chief Minister of Andhra Pradesh, to train the women students as better builders of the nation and to inculcate skills of leadership in all aspects of life.

Computational Engineering (CE) is a relatively new discipline that deals with the development and application of computational models and simulations often coupled with high-performance computing to solve complex physical problems arising in engineering analysis and design in natural phenomena.

Bio Engineering (BE) is a significant task of computational biology, and computational bio systems aim to develop and use efficient algorithms, data structures, visualization and communication tools with the goal of computer modelling of biological system. It involves the computer simulations of biological systems which includes cellular subsystems to analyse and visualize the complex connections of these cellular processes. In addition, computational models help investigators to systematically analyse system perturbations, develop hypotheses to guide the design of new experimental tests and ultimately assess the suitability of specific molecules as novel therapeutic targets. Today, engineering approaches are essential for biologists, enabling

them to analyse complex physiological processes as well as for the pharmaceutical industry as a supporting drug discovery and development programme.

The tradition and root of this conference is to bring researchers from the international scientific community to discuss the advancements and the future perspectives in Data Science, Big Data Analytics, Cloud Computing, Bio Engineering, Computational Biology, Biomaterials, Bioinformatics and Biomedical fields.

Nowadays cloud and big data are new platforms to manage and analyse the biological databases. To address these aspects, scientists with computer science, biotechnology background, academicians, decision-makers, policy-maker's stakeholders, students, government agencies, industries and public consumers have shared their research finding and thoughts on this international conference.

The authors submitted more than 200 papers from across the global. This certainly attests to the widespread, international importance of the theme of the conference. Each paper was reviewed on the basis of originality, novelty and rigorousness. After the reviews, 90 papers were accepted for presentation, out of which 76 papers are finally being published in the proceedings.

The event was a 2-day programme comprised of 10 paper presentation sections. The themes are contributed, and scientific sessions range from theories to applications, reflecting a combination of computational and bio engineering. We are very gratified to have an exciting line up of featured speakers who are among the leaders in changing the view of computational bio engineering.

Anantha S. Babbili (Ph.D., The University of Iowa) is former Provost and Vice President for Academic Affairs of Texas A&M University-Corpus Christi (2007–2010) and former Dean of the College of Mass Communication (2002–2007) at Middle Tennessee State University. Invited as a chief guest has given gratitude for meeting researchers from around the world, widens professional contact to create new opportunities including establishing new collaborations. **Samuel jones** has been invited as Keynote Speaker, who is working as a **Sr. Principal IT Architect, USA** and has given a view on the role of bioengineering and the potential of computational methods for ground breaking healthcare products, therapies and services. **Prof. El-Sayed A. El-Sheikh**, **Zagazig University, Egypt** has been invited as Guest of Honour, and has encouraged the delegates to study the biology relating with computational engineering to be developed and the applications of computational models are simulations to solve complex physical problems for analysing and designing.

We give our gratitude to **Prof. D. Jamuna**, **Vice Chancellor of SPMVV** who has given valuable thoughts.

The conference would truly not be successful without the contributions and support received from authors, participants, keynote speakers, programme committee members, session chairs, organizing committee members, steering committee members and others in their various roles. Their valuable support, suggestions, dedicated commitment and hard work have made the **CBE'20** successful.

It has been a great honour to serve as programme chairs for the **CBE'20** and to work with the conference team. We believe this event will certainly help further disseminate new ideas and inspire more collaborative work.

Tirupati, India — Prof. S. Jyothi
Tirupati, India — Prof. D. M. Mamatha
Leicester, UK — Yu-Dong Zhang
Secunderabad, India — K. Srujan Raju

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About the Editors

Dr. S. Jyothi is Senior Professor and Head of the Department in Computer Science at Sri Padmavathi Women's University, Tirupati, Andhra Pradesh, India. She is also Secretary of SPMVV Society for Innovation Incubation Entrepreneurship (SSIIE) which has TBI & WBIF, Coordinator of CURIE-AI, National Innovation Startup Policy (NISP), Coordinator and Vice-President of Institute's Innovation Council (IIC). She handled many administrative positions in the University. She is BOS Member of several Universities. She is NAAC peer team Member. Seventeen Ph.D.s and seven M.Phil.s were awarded and nine Ph.D. scholars are being guided under her supervision. More than 250 papers published and presented in international journals and conferences. 12 book chapters are published and 12 books are authored and edited by her. She has filed 2 patents and one international patent publication in her credit. She has conducted 3 international and 4 national conferences, 10 hands-on workshops & faculty development programmes and acted as Keynote Speaker, Invited Speaker and Session Chair of international and national conferences.

She has completed UGC, DBT major Projects and ISRO-NRSC consultancy projects and handling DBT major project. She is honoured and awarded Marquis Marque Lifetime achievement award, Venus Lifetime achievement award, Best Research award, AP State Best Teacher Award, Rashtriya Gaurav Award and Best Citizens of India Award. She acted as Editorial Board Member of international journals, Technical Committee Member of international conferences and Reviewer of many research papers for international journals and international conferences. She is Senior Member of IEEE, ACM and IACSIT, Fellow of ISCA, IETE & SSARSC, Member of IAENG & Gyancity Research Labs and Life Member of CSI, ISTE, ISCA, IFERP, IUPRAI and ISRS. Her research interest is in image processing, artificial intelligence, machine learning, soft computing, data mining, big data analytics, bioinformatics and hyperspectra image analysis.

Dr. D. M. Mamatha is Fulbright Scholar and Professor from the Department of Bioscience & Sericulture at Sri Padmavathi Women's University, Tirupati, Andhra

Pradesh, India. She is the current Registrar of Sri Padmavati Women's University. She obtained six major collaborative multidisciplinary research projects from DBT, DST and UGC to the tune of Rs. 250.56 lakhs (approximately) and completed three international research fellowships like Indo-US & Indo-Egypt and Fulbright Fellowship during the period 2010 to 2018. Her area of research is wide ranging on cloning, expression, rDNA technology, DNA barcoding and silk biomaterials. She had been to several countries, viz. Singapore, Malaysia, Thailand, USA, Hong Kong, Canada, Egypt, Nepal and USA on various academic, research and international collaborative assignments. Her relentless efforts made her to publish several international publications in Scopus journals with high impact factor and a high citation index of 1505. Her works speak about her scientific calibre, which had been appreciated and posted in UCDAVIS website by her mentor Prof. Bruce Hammock, Distinguished Professor and Well-Renowned Scientist upon her visit to UCDAVIS.

Apart from the 'Fulbright award', Dr. Mamatha received several significant awards like 'Achievement award' from WHO-UNESCO, 'DBT-Young scientist Associateship' award from Government of India, Twice received INSA-NASI-IAS 'National science academies Summer research fellowship awards' for the years 2009 and 2011, 'Best Teacher award' from The Lion's club, 'Best Research award' from Indus foundation, and several 'Best research paper' and presentations awards which demonstrate her academic and research capacities. Her multidisciplinary research on automated identification of prawn species using DNA coding and neural networks has gained research team a national and international patent for the technology generated. Another thrust area is the 'Development of Silk fibroin Biomaterials' on the offing, where India has a large potential to hit in the coming years. She is currently guiding postdocs, Ph.D.s and M.Phil. scholars. One postdoc, two Ph.D.s, and one M.Phil. and several master's course dissertations have been awarded under her guidance. She published 5 books and contributed 5 chapters to different books from reputed publishers.

Dr. Yu-Dong Zhang (Eugene) is Professor and Chair in Knowledge Discovery and Machine Learning. He has Memberships in Associate Fellow of Higher Education Academy, IEEE Senior Member, ACM Senior Member and Fellow of IET. He has more than 400 publications with 12654 citations in Google Scholar with h index 62 and 8336 citations in Scopus with h index 52. His research interest includes deep learning, convolutional neural network, neural networks, biomedical image analysis, bio-inspired computing, pattern recognition, transfer learning, biomedical image analysis, etc. Dr. Yu-Dong Zhang is Honorary Professor of Henan Polytechnic University and King Abdulaziz University. He won MDPI Top 10 Most Cited Papers 2015 from MDPI, Switzerland, Emerald Citation of Excellence 2017, Emerald, UK, 'Top Scientist' in Guide2Research, Most Cited Chinese Researchers (Computer Science) by Elsevier, Highly Cited Researcher 2019 by Web of Science and Springer Nature CNY2020 Collection by Springer Nature. Dr. Yu-Dong Zhang (Eugene) served as (Associate) Editor of Neural Networks, Scientific Reports, Journal of

Alzheimer's Disease, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Access, Neurocomputing, etc. He served as Leading Guest Editor of Information Fusion, Neural Networks, IEEE Access, etc.

He served as Guest Editor of IEEE Transactions on Intelligent Transportation Systems, International Journal of Information Management and other peer-reviewed journals. He served as General Chair/ Co-Chair/TPC Chair/ Workshop Chair/ Session Chair of IEEE/Springer conferences. He has delivered academic talk in Doctoral School Teaching and invited talks in reputed Universities. He served as Senior Committee Members in number of conferences. He has research team which consists of 3 staffs, 8 Ph.D. students and 12 visiting students/scholars. Dr. Yu-Dong Zhang has several research projects in various disciplines from various funding agencies.

Dr. K. Srujan Raju is currently working as Dean of Student Welfare and Heading Department of Computer Science & Engineering and Information Technology at CMR Technical Campus. He obtained his Doctorate in Computer Science in the area of Network Security. He has more than 20 years of experience in academics and research. His research interest areas include computer networks, information security, data mining, cognitive radio networks, image processing and other programming languages. Dr. Raju is presently working on 2 projects funded by Government of India under CSRI & NSTMIS; he has also filed 7 patents and 1 copyright at Indian Patent Office, edited more than 14 books published by Springer Book Proceedings of AISC series, LAIS series and other which are indexed by Scopus, also authored books in C Programming & Data Structure, Exploring to the Internet and Hacking Secrets, contributed chapters in various books and published more than 40 papers in reputed peer-reviewed journals and international conferences.

Dr. Raju was invited as Session Chair, Keynote Speaker, Technical Programme Committee Member, Track Manager and Reviewer for many national and international conferences and also appointed as Subject Expert by CEPTAM DRDO – Delhi & CDAC. He has undergone specific training conducted by Wipro Mission 10X & NITTTR, Chennai, which helped his involvement with students and is very conducive for solving their day to day problems. He has guided various student clubs for activities ranging from photography to Hackathon. He mentored more than 100 students for incubating cutting-edge solutions. He has organized many conferences, FDPs, workshops and symposiums. He has established the Centre of Excellence in IoT, Data Analytics. Dr. Raju is Member of various professional bodies and received a Significant Contributor Award and Active Young Member award from Computer Society of India and also served as Management Committee Member, State Student Coordinator & Secretary of CSI – Hyderabad Chapter.

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Metaheuristic Optimization Using Hybrid Algorithm in Cloud-Based Big Data Analytics

Amitkumar Manekar and G. Pradeepini

Abstract Task Scheduling is a prominent research topic in cloud computing. There are several objectives associated with Optimise Task Scheduling and Resource allocation as cloud computing systems are more complex than the traditional distributed system. There are several challenges such as resolving the task mapped to the node on which task to be executed. Modelling deadline or make spam parameter, task reliability, various task allocation strategies, etc. A simplified but near-optimal proposed nature-inspired algorithms are focus in this paper. In this paper, a basic idea about optimisation, reliability, and complexity is considered while designing a modern BDA solution (Big Data Application). In this paper, we focused on Dragonfly algorithm and Sea lion algorithms which are nature-inspired algorithms. These algorithms are efficient for optimisation purposes for solving task scheduling and resource allocation problem. Finally, the performance of the DA algorithm and Sea lion is compared with the Genetic Algorithm (GA) and Particle Swarm Optimisation (PSO) for modern BDA such as Hadoop Map reduce. Simulation results prove the efficacy of the suggested algorithms

Keywords Resource allocation · Cloud · Big data · Deadline · Utilisation cost · Migration · CDSLnO

1 Introduction

In the modern era of computing such as bioinformatics, astronomy, physics, smart computing, weather data analysis, and modelling, and for any data-driven scientific applications, cloud computing with Big data application is used. All those technologies are dependent on fair share policy of task scheduling and resource

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sharing. Execution of all data-driven and data-intensive workflow depend of fast and parallel executions of BDA. BDA uses extensive use of the reasonable amount of time demands a high-performance computing environment. Cloud computing needs computing resources on demand and virtualisation is a prominent solution to this [1]. It is necessary to schedule workflows on cloud in a way that reduces the cost of leasing resources. Scheduling tasks on resources is a NP hard problem and using meta-heuristic algorithms is an obvious choice for the same. In this paper, work is stimulated to Nature-inspired algorithms like particle swarm optimisation such as Dragonfly algorithm DA and Sea lion algorithm [9, 10].

2 Related Works

Table 1 shows the reviews on task scheduling in cloud computing. At first, MR

Table 1 Features and challenges of task scheduling in cloud computing using various techniques

Author [citation]	Adopted methodology	Features	Challenges
Lee et al. [1]	MR algorithm	• High speed • Reliability and scalability	• Failure rate noise has to be focused more
Chen et al. [2]	MUMTO approach	• Minimal cost • Optimal run time	• Have to analyse the user mobility
Simic et al. [3]	ANN framework	• Speedy delivery of results • Minimised infrastructure cost	• No consideration on QoS requirements
Najme et al. [4]	PSO model	• Minimised implementation time • High efficiency	• Fault tolerance constraints are not taken into account
Fredy et al. [4]	MHRA scheme	• Better scheduling solution • Minimises the cost function	• Need consideration on energetic models to evaluate the cost
Zhang et al. [5]	PSO	• Minimised execution cost • Optimal convergence speed	• Dynamic slack time could not be exploited here
Srichandan et al. [6]	BF algorithm	• Minimises the make span • Reduced energy consumption	• Similarity function has to be focused more
Zhang et al. [7]	Dynamic game theory	• Minimised make span • Reduced workload of machines	• The real time generation of scheduling is not considered

algorithm was introduced in [1] that offers high speed, and it also offers better reliability and scalability. However, failure rate noise has to be focused more. MUMTO approach was exploited in [2] that offers minimal cost and it also offers optimal run time, but it has to analyse the user mobility. "ANN framework was used in [3] that reduce the infrastructure cost and it also offers speedy delivery of results. However, there was no consideration on QoS requirements. In addition, PSO was implemented in [4] that attain minimised implementation time along with high efficiency, nevertheless, fault tolerance constraints are not taken into account." MHRA theory was presented in [4] that offers minimised the cost function with better scheduling solution, but the energetic model is not considered. Moreover, PSO was implemented in [5], which minimised execution cost and optimal convergence speed. Nevertheless, it poses low searching efficiency. In addition, BF algorithm was suggested in [6], which reduced make span and minimal energy consumption. However, the similarity function has to be focused more. Dynamic game theory was introduced in [7], which minimises the make span with a reduced workload. These limitations have to be considered for improving the performance of cost optimisation in the cloud effectively in the current research work.

3 Problem Definition

In cloud computing, especially workflows in IaaS clouds using nature-inspired algorithms are considered in this work. Metaheuristic optimisation algorithms are simpler to implement and best suited for cloud computing [8]. Above all, they can minimise local optima and they can be applied in a wide range of issues covering various disciplines [5, 6]. In ultra large scale and high scalability such as cloud computing, large resource pools and idle resources are available. Dynamic allocation of application and mapping resources to these applications are treated with fair resource sharing policy in all BDA.

These natures-inspired metaheuristic EA are designed on multi-objective functions. In this work, we have considered Deadline, Utilisation Cost, and Migration Cost as objective for solving large-scale real-world optimisation problems over heterogeneous computing resources. The main objectives of the research are

(1) "To make a clear review on different research works related to cost optimisation-resource allocation and task scheduling in cloud and also to define the clear problem statement on this aspect."
(2) "To design a new model for cost optimisation, particularly resource allocation in cloud under big data analytics with Hadoop or Spark, etc."
(3) "To introduce a new hybrid algorithm for solving the cost optimisation problem that obviously enhances with respect to better convergence rate and speed, respectively."

(4) "To make a clear comparison of proposed model with other state-of-the-art models with respect to different analysis under cost saving, deadline and task completion."

4 Methodology

This model insists on optimising resource allocation and migration with respect to certain constraints or parameters such as Deadline, cost saving and utilisation cost (resource saving). Moreover, this proposal aims to define a new objective function that combines fine-grained resource allocation and migration process execution. For this, a new hybrid algorithm that hybrids the concept of Dragonfly (DA) and Sea Lion Algorithm (SLnO) is introduced. DA [4] is a new meta-heuristic optimisation approach that solves the single-objective, discrete and multi-objective problems. The "SLnO algorithm [4] imitates the hunting behaviour of sea lions in nature. Moreover, it is inspired by sea lions' whiskers that are used in order to detect the prey."

A. Proposed CD-SLnO Algorithm

"Minimal internal memory, and slow convergence" is a drawbacks of existing DA [4–6] though it performs precisely. To overcome this we can use the concept of SLnO is merged with it to introduce a new hybrid model. Hybrid optimisation algorithms have been reported to be promising for certain search problems [5]. The working computation procedure of proposed hybrid CD-SLnO model is as follows: "DA includes two significant stages: (i) Exploration and (ii) Exploitation." The proposed logic which we are introducing as follows is as follows: "Conventionally, the modelling for separation and cohesion are computed based on S_l and S." As per the proposed logic, the separation and cohesion formula are computed as per "Eqs. (1) and (2), where $\bar{B}$ denotes a random vector obtained from SLnO algorithm [4], S_l indicates the lth nearer individual position,S signifies current individual position and U reveals the count of the nearby individuals."

$$C_i = -\sum_{l=1}^{U} \left(2\bar{B}S - S_l\right) \tag{1}$$

$$O_i = \frac{\sum_{l=1}^{U_b} S_l}{U_b} - 2\bar{B}S \tag{2}$$

B. Computational Analysis by varying No. of Tasks

The computational time analysis of the suggested CD-SLnO model is summarised in this section by varying the counts of VM from 20 and 40. Table 2 "reveal the time (represented in minutes) utilised by the presented CD-SLnO approach over the conventional models with respect to varied number of tasks from 200, 400, 600, 800,

Table 2 Analysis on proposed model over existing models by varying the number of virtual machines

No. of tasks	MTA-S [1]	PSO + GA [6]	MSDE [9]	CD-SLnO
VM = 30				
200	7.300469	1.585228	2.834687	0.944865
400	9.634184	3.848147	5.559878	3.711675
600	21.8097	16.27314	21.47189	3.744312
800	23.61543	20.57337	23.11756	7.027397
1000	29.73418	25.47303	29.22491	9.739561
1200	38.1482	33.61701	37.94493	12.98874
VM = 40				
200	7.11672	1.558116	2.934807	1.033701
400	9.420927	3.901276	6.140882	2.043776
600	12.29334	7.368898	9.946115	3.32982
800	22.0944	17.67865	20.88112	6.864799
1000	30.24161	25.93365	29.28711	9.751759
1200	38.53181	34.13123	37.9366	12.69217

1000 and 1200. For a better performance of the system, the computing time has to be minimal, which is attained by the presented model. Predominantly, the computing time of the presented method for VM = 20 is 87.05%, 40.39% and 66.67% better than existing MTA-S, PSO + GA and MSDE models when the number of tasks is 200." In addition, the computing time of offered scheme for "VM = 40 has attained a minimal value of 3.32982, while the existing MTA-S, PSO + GA and MSDE schemes have achieved the higher computing time of 12.29334, 16.27314 and 21.47189 when the number of tasks is 600." Thus, the improvement of the presented CD-SLnO method has been established from the analysis outcomes.

5 Conclusion

This paper has introduced a novel resource allocation model, which combined resource allocation and the migration process. Moreover, an optimisation concept named CD-SLnO was developed for resource allocation and migration by considering the parameters such as deadline, utilisation cost and migration cost. In the end, comparison was made for validating the betterment of the presented scheme over existing models. On observing the outcomes, the presented CD-SLnO model has accomplished optimal values when computed over the compared models. Primarily, the computing time of the suggested method for "task = 250 was 85.1%, 43.35% and 66.35% superior to traditional MTA-S, PSO + GA and MSDE models when the number of VM was 50. Furthermore, the computing time of the implemented

scheme for task = 500 has obtained a minimal value of 2.524837, whereas the evaluated MTA-S, PSO + GA and MSDE schemes have obtained higher computing time values 11.09581, 5.413038 and 7.63648 when the number of VM was 50. Thus, the enhancement of the presented CD-SLnO model was proved in an effectual manner."

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Analysis of Data Aggregation Methods to avoid Data Redundancy in Wireless Sensor Network

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***Abstract*- Internet of Things (IoT) may be with large number of different technologies to make devices capable to interact with each other. The IoT with all these advanced technologies and devices making a rapid change of society towards easier and smarter. In IoT environment, nodes or sensors may used to collect the data and wireless communication technologies are used to transceive sensed data. IoT can involve number of sensor nodes, but with limited sensing, computational, and communication capabilities. Due to such limitations, the data size should be lower weight to improve the efficiency of the sensor nodes and bandwidth utilization of a network. To achieve network efficiency by avoiding data redundancy, the concept of data aggregation came into the picture. Data aggregation is the process of combining data from various sources and route them after removing redundancy such as to improve the overall network lifetime. When data aggregation is performed a notable communication complexity reduction rate and energy consumption reduction rate observed, hence we have studied and analyzed various Data Aggregation methods with their working methodology, features, limitations, drawbacks, results, etc. to conclude best suitable.**

Keywords– Sensors; Data Aggregation; Wireless Sensor Network

I. WIRELESS SENSOR NETWORKS

Internet of Things (IoT) ecosystem involves physical devices like sensors and actuators with the Internet. As per the requirement of data, different types of sensors are available to sense the values from an environment. Sensors make IoT capable for smarter decisions by collected data as input. Sensors are capable to sense the data such as magnetic, thermal, seismic, visual, infrared, acoustic, noise level, rain, soil erosion, radar, temperature, pressure, humidity, vibration, radiation, object movement, object presence, mechanical stress levels, color, speed, direction, and also the size. Sensors can be use for continuous sensing, event detection, location sensing, and local control. [1]

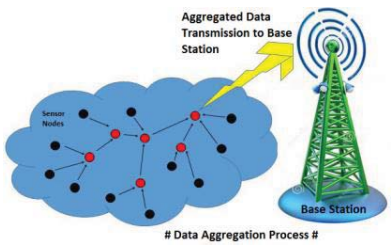
The IoT consists of sensor network so that sensor can interact. The IoT involves various heterogeneous technologies and devices that make possible for interaction. Today mostly systems are based on smart sensor networks mainly wirelessly known as a Wireless Sensor Network (WSN). WSN senses the values in an environment from scattered sensor devices. WSN should provide energy-efficient, flexible and low-cost wireless communication for system automation applications, therefore routing protocols of networks must be design by considering the limitations of power, processor's capacity, and memory of sensor devices.

II. DATA AGGREGATION

In WSN, the number of sensors sensed the application-specific data and transferred to a central Base Station (BS) to processed, analyzed, and used by the applications; such distributed in-network processing of data is generally referred to as Data Aggregation (DA). In these limited resources network, the normal approach is to first perform jointly processing of data before forwarded toward the BS. DA schemes describe the way for collecting the data which may be either event-driven, time-driven query-driven or both time and event (hybrid) driven.

Without DA, sensor nodes perform reporting with all the raw data to the sink i.e. the transmission of redundant data is meaningless that tend to various drawbacks: 1) repeated data transmission 2) increase in network traffic, demands of large bandwidth 3) increase in network congestion, and 4) increase in energy and time consumption.

DA is a process for statistical analysis where information is collected and expressed in summary form. The collected data relates to an event in sensor network or it's around. It minimizes repeated transmissions to the sink by aggregating and eliminating similar data from multiple nodes.



III. ISSUES WITH DATA AGGREGATION

DA has the following issues as:

1) Redundancy: Increase of number of nodes in network causes the increase of data redundancy. Some sensor nodes sense the same kind of data, and forward it all to sink node over the network. This leads to the energy wastage for transmission of redundant data. Therefore, the methods for elimination of such redundant data to enhance the network

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lifetime and throughput are needed. The following are the methods for elimination of redundant data during DA in WSNs: a) at intermediate node level, b) at cluster head level, and c) at sensor node level.

2) Latency: In a network, the number of nodes cause variations in terms of time taken for DA at nodes, called as aggregation time.

3) Computation Overhead: Increase of number nodes in the network causes the increase in percentage of computation overhead for data processing during DA.

4) Data Accuracy: During aggregation, node (could be Intermediate node or cluster head or sink) performs the DA task and move it to sink over the network. The redundant data transmission leads to data inaccuracy in WSNs.

IV. Analysis of Data Aggregation Methods

The primary objective of DA is to enhance the network lifetime by minimizing energy and bandwidth consumption by the sensors. While increasing network lifetime, quality of service metrics may degrade in WSN, such as data accuracy, latency, fault-tolerance, and security. To achieve efficiency, DA schemes focus on the route of the packets through a network. Hence, sensor network architecture has a vital role in the DA protocols performance. There are many DA schemes categorized as 1) backbone-based structures (backbone, dominating set), and 2) hierarchy based structures (tree or cluster based structures).

1) Backbone based Structures (Backbone or Dominating Set)

Here, the backbone path i.e. connected dominating set is defined in the network. Each node forward data to sink individually and the backbone nodes perform data aggregating. These types of structures facilitate the data dissemination process to be useful for mobile sink applications.

1.1) Directed Diffusion Method (DD):

[2] Bin Zhou, et al. (2006) reviewed 'Directed Diffusion' (DD) method for DA. Here, to extract data from sensor networks a sink first sends out queries with an interesting message in DD which broadcasted in a sensor network so that every node receives it. In the interest messages broadcasting, gradients (reply link) are established between sink and neighbors from whom the interest was received.

If nodes have similar data, they return sample sensed data called as exploratory data (ED). When these ED reach the sink from different gradients then several paths are established between sink and source. From these several paths, the sink selects one path to the source by sending message reinforcement. Finally, the actual data return from the source, following the selected path.

Limitations:

1) Gradients provide limited information based on the sequence of interests it receives;

2) A node can recognized only its nearest node.

3) At returning of an ED, each node has to rely to its all neighbors, but it does not get that which neighbor is capable to pass message to the sink, therefore many other unnecessary nodes involved even sink and source are neighbor.

3) For multiple sources and one sink, DD performs in-network DA so such aggregation may not efficient because path based sink selections on limited information and also DD involves unnecessary data transmissions.

1.2) Improved Energy-Efficient Directed Diffusion Method (IEEDD):

In DD the reinforcement mechanism generally chooses the neighbor with the fastest response or the maximum packets receiving capacity, this scheme has many drawbacks. To overcome these above-defined limitations of DD method, [3] Shimaa Gamal El-Esawy, et al. (2018) has experimented 'Improved Energy-Efficient Directed Diffusion Method' (IEEDD) by modifying the conventional DD by performing 1) average remaining energy of the nodes on the path, and 2) minimum remaining energy of a node on the path.

In this, the path selection is as per the highest average remaining energy and the minimum energy of a node. The energy metric for all paths replay is calculated and the highest cost function (i) path is selected.

$$EM(i) = a\ minE + b\ (totalE\ /\ hopC)$$

Here: '$minE$' is an energy of the node with minimum residual energy along the path, '$totalE$' is the sum of total residual energy of all the nodes, '$hopC$' is the hop count from the source to the destination node and 'a', 'b' are the weights according to the application needs.

This method is mainly uses to selects a dependable path for drawing down the required full data and to avoid network partitioning or death and finally to ensures a successful data delivery. Experimentally the performance of the IEEDD is compared with DD; it shows that the IEEDD has less total energy consumption that makes a longer lifetime than the DD.

1.3) Railroad Architecture Method:

[4] Jeong-Hun Shin, et al. (2005) proposed 'Railroad: virtual infrastructure for data dissemination', which operates as a rendezvous area for events and queries. It analyzed that, Rail-road and Rail-node consume less energy than Geographical Hash Table (GHT)/Two-Tier Data Transmission (TTDD) and home node respectively. Here some assumptions are considered, 1) the sensor nodes are randomly installed without centralized authority to control i.e. to restrict network scalability, 2) each node has its location detail (based on a physical coordinate system or a virtual coordinate system), 3) here in the network, queries and event messages are generated by multiple mobile

observers and targets, and 4) it achieved uniform event generation probability over a network.

After new data generated by source, source sends it to the rail-nodes to aggregate it. Here it needs to collect the data generation report; hence a query message is broadcasted into the rail until it reaches the rail-nodes that maintain the relevant source node detail. However, the delay is a problem for railroad.

1.4) Ring Routing Method (RR):

[5] Can Tunca, et al. (2014) demonstrated 'Ring Routing (RR): An energy-efficient routing protocol with a mobile sink', which is virtual ring structure designed hierarchical routing protocol for easy accessibility and re-configurability. Its structure is a closed loop of single-node width which encapsulates a globally predetermined center.

Whenever needed, it allows the new sink position to be easily delivered to the ring and regular nodes to acquire the sink position from the ring with minimal overhead. The ring structure can be change easily as the ring nodes can switch roles with regular nodes in a straightforwardly and efficiently. The mobile sink selects anchor nodes from its path which relay sensor data to the sink. The design requirement of a protocol is to mitigate the hotspot problem and to reduce the data reporting delays considering the various mobility parameters of the mobile sink.

Experimentally observed, that it relies on a minimal amount of broadcasts, hence useful for sensors utilizing asynchronous low-power MAC protocols designed. RR is an energy-efficient protocol to extend the network lifetime and within reasonable limits the reporting delays confined and to make it suitable for time-sensitive applications. The ring construction for large or sparse networks is complex.

1.5) Data Quality Maximization Method (DQM):

[6] Liang and Wark (2011) demonstrated 'Data Quality Maximization' in sensor networks with a mobile sink which is backbone based consisting of gateways. For data collection in densely deployed WSN, a mobile sink moves along a pre-defined fixed trajectory with a constant speed without stopping at the time of data uploading from the gateways to the mobile sink is limited. The sensors used the shortest routes with the gateways by using the 'Floyd-Warshall' algorithm. Gateways aggregate incoming data, hold it until the sink moves into their transmission ranges.

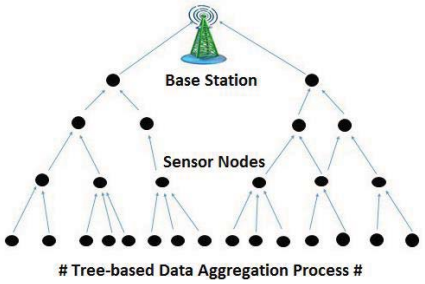
Experimentally, observed that the energy consumed on data collection per tour 1) decreases as the value of 'n' (|Set of common sensors|) increases with constant 'm' (|Set of gatewaysl), 2) as per the total quota, the more number of packet nodes are chosen so more accurate data estimation is delivered, and 3) energy consumption increases as total quota increases since data from more common sensors needs to be transmitted.

2) Hierarchy Structures (Tree or Cluster Structures):

Hierarchy structures allow sensor nodes to form a hierarchical shape network, such as a tree or a cluster. In hierarchy structured network data is always transferred from lower-level to higher-level nodes and aggregation is performing by higher-level node.

A) Tree-based Data Aggregation Methods:

WSN has several small, low power and limited communication range sensors that cooperatively have to sense the environment and transmit the data through a route to the BS or the Sink. For data transmission over long distances, more energy is required. Hence, in many cases, nodes communicate with the sink node through their neighbors.



Tree-based Data Aggregation Process

In this case, each node should know which neighbor is more appropriate for packet transmission. Hence, energy-efficient protocol design is essential to reduce the total energy consumption and to distribute energy steadily and uniformly to the network nodes. In the tree-based DA, periodically sensors receive messages from children, the sensor merge received message with their packet and forward it to its parent node.

2.A.1) Hierarchy Data Aggregation Method (HDA):

A hierarchical structured data aggregation method is called 'Hierarchical Data Aggregation' (HDA). [2] Bin Zhou, et al. (2006) experimented that HDA i.e. enhanced scheme of DD can save up to 50% transmission energy without any compromise in reliability or delivery efficiency. HDA facilitates greater level DA in the data-centric routing scheme. Due to the hierarchy pattern, each node has their neighboring node details such as their parents and children.

In HDA, nodes between the sink and the source are arranged in a hierarchy pattern i.e. packets are only transmitted between two nodes in neighboring levels. Here, initially, the network begins with all sensors at the basic level of the hierarchy and a subset of the aggregators is selected at each level to act as aggregators at the next higher level. Once the aggregation hierarchy is established, sensor nodes sensed the data and transmit it to their nearest high-level aggregator. These aggregators receive data, perform aggregation and forward ahead to its nearest next high level node. This process continues until the data is forwarded to the sink [7].

2.A.2) Tiny Aggregation Method (TAG):

[8] Samuel Madden et al. (2002) have experimented, the 'Tiny Aggregation' (TAG), a data-centric protocol based on a tree structure. It is designed specifically for monitoring applications that allow an adjustable sleep schedule for sensors. There are two phases, a) distribution phase and b) collection phase. In the first phase, aggregate queries are pushed down into a network i.e. sink broadcasts queries to the target node to let them about the waiting period. From the query message, the route from the sink to a node is established. In the second phase, aggregate values are continually routed up from children to parent i.e. each parent fetches their child information to prevent data loss, and pass this aggregated data up the tree.

TAG is a very promising service for data collection as it expresses simple and declarative queries to efficiently distribute and execute in low-power WSN. The TAG has two needs, the sink has to deliver query requests to all the network nodes, and each node has a minimum one route to the sink. Due to this requirement TAG faces many challenges regarding dynamic topologies or link failures.

2.A.3) Opportunistic Data Aggregation Method (OPAG):

TAG is susceptible to data loss during communication occurs, to overcome this problem in [9] Chen & Shin (2008) experimented 'Opportunistic Data Aggregation Method' (OPAG). It is an approach to achieve zero computation error and good tolerance to moderate message loss in WSN. OPAG opportunistically uses a multi-path routing system, which is more energy-efficient than re-transmission; reducing the energy cost by 33% but the relative error is slightly higher. This scheme is based on the observation that, when sending a message, the radio consumed much more energy in idle listening during the back-off period and the time to wait for its acknowledgment than transmitting the data bits.

It separates DA in two layers network: (a) at the data-aggregation layer, aggregation results are computed exactly along an overlay tree; and (b) at the underneath routing layer, a node opportunistically uses a multipath routing scheme to send its partial result to a data aggregation node. To compensate for message losses, OPAG uses multipath routing if the redundant paths give a success ratio no less than 'p', and use retransmissions if there is no redundant path or the multiple paths yield a success ratio less than 'p'.

2.A.4) Greedy Aggregation Method (GA):

[10] Chalermek Intanagonwiwat, et al. (2002) experimented that 'Greedy Aggregation' (GA) without compromised latency and robustness achieves approx 45% energy savings over OPAG. GA is an approach to adjust aggregation points to increase the amount of path sharing so reducing energy consumption. Its style for path establishment and maintenance is different than opportunistic aggregation called as a greedy incremental tree (GIT). In the construction of a greedy incremental tree, only for the first source to the sink the shortest path is established whereas all other sources are incrementally connected at the closest point on the existing tree.

2.A.5) Energy-Aware Data Aggregation Method (EADA):

[11] Nen-Chung Wang et al. (2007) published 'Energy-Aware Data Aggregation' (EADA) for transmitting data to a mobile sink; it approaches a grid-based tree structure for on-demand data dissemination. Here, gateway 'G' with most residual energy is selected to detect an interest, it propagates an inquiry to all the other gateways using simple flooding in a grid, i.e. all the gateways know the status of an event. 'G' is responsible for the aggregation of the generated data within the grid. When a mobile sink has to know the status of an event, it sends an inquiry to gateways for its presence in the same grid. The gateway receives the request and sends a reply to the mobile sink. Then the gateway to which the mobile sink belongs sends a query message to 'G'.

Once the query receives at the interest zone, the entry gateway becomes the root of a newly constructed tree which covers all the nodes in the interest zone. The aggregated data then disseminated reverse through the query route to the sink. If the root gateway energy goes below a threshold, the gateway with most residual energy in the interest zone is selected as a new root and a new tree is formed.

The root selection is based on the maximum residual energy hence; the root is variable. The continuous change in root establishing and maintaining a separate tree for each interest zone, it may increase the overall energy consumption in the network

2.A.6) Minimum Energy Cost Aggregation Tree Method (MECAT):

[12] Tung-Wei Kuo et al. (2012) defined NP-Completeness and Approximation Algorithms for the construction of 'Minimum Energy Cost Aggregation Tree' (MECAT) to minimize the total energy requirement for data transmission. Here, algorithm analyzes the tree construction under certain aggregation ratio. For efficient transmission, data have to route each packet via the shortest path to the sink as it is observed that in data packet transmission to the sink, the longer routing path have larger the energy cost.

Three are notable benefits to route packets using a shortest-path tree. 1) It is easy to construct in a distributed manner, as i) the sink node first broadcasts a message so that each node can evaluate the hop distance from the sink, ii) then, each node sets its parent to the node with a smaller hop distance from the sink, 2) It has minimum packet transmission delay and, 3) The algorithm is irrelevant to the aggregation ratio and report sizes, so it can be applied where the aggregation ratio or report sizes are unknown or they vary time to time.

Here, two types of problems are investigated i) without relay nodes, an aggregation tree such that every node sends only one packet, is NP-complete, and ii) with relay nodes, when relay nodes are deployed, some relay nodes might

have degree more than two, that is, some relay nodes can forward packets from two or more nodes, is Steiner tree problem. Both of them are shown to be NP-complete. For first, a shortest-path tree algorithm turns out to be a 2-approximation algorithm and can be easily implemented in a distributed manner. For a second, shortest-path tree algorithm and a Steiner tree algorithm each have bad performance in the worst cases.

The authors demonstrated an O(1) - approximation algorithm by constructing a shortest-path tree on the routing structure of the Capacitated Network Design problem. It has experimented that, proposed algorithms have good performance in terms of the energy cost and for data aggregation with relay nodes; a tree might outperform a non-tree structure in terms of the energy cost. The reason is in a tree, the data is concentrated in a small number of nodes, resulting in the efficient utilization of packets.

2.A.7) Cuckoo Optimization Algorithm (COA):

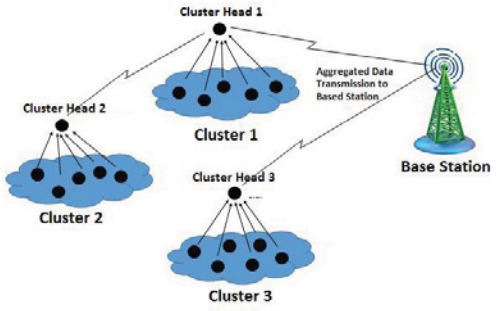
A Cuckoo Optimization Algorithm (COA) is a data aggregation tree that optimized energy consumption in the network. [13] Mohsenifard and Ghaffari (2016) demonstrated to compare a COA with a genetic algorithm (GA), Power-Efficient Data gathering and Aggregation Protocol Power-Aware (PEDAPPA) and energy-efficient spanning tree (EESR). The result shows that the proposed method is good in performance than GA, PEDAPPA and EESR algorithm in terms of energy consumption. Consequently, the proposed method was able to enhance the network's lifetime.

In this, a network consists of ‘n' wireless sensors with a transceiver of a maximum transmission range. This work adopts the use of multi-hop transmissions in its communication model. For this purpose, a tree is constructed. In-network aggregation at intermediate nodes usually results in reducing the size of data that is forwarded by an intermediate node to its parent [7]. An undirected graph, i.e. G (V, E), was used for featuring the sensor network with V nodes which was produced based on the distance between nodes and the radio range. The random graph was produced in the following way: V sensors were randomly placed in a pre-specified environment where they were connected to their neighbors with the Euclidean distance equal to or less than their radio range.

B) Cluster-Based Data Aggregation Methods:

[15] In WSN the data of individual nodes are correlated to each other; the end-user does not need all the (repeated) data. The end-user only needs a high-level function of data to know the events occurring in the environment. As the strongly correlated nodes are always located close to each other, it's easy to form the clusters of such nodes. The local processing of data within the cluster reduces the amount of data to be transmitted to the end-user; particular DA methods can be used to combine several correlated data.

Clustering Data Aggregation composed of a hierarchical structure of nodes where sensor nodes are divided into several clusters (a group of nodes) with a particular node as a Cluster Head (CH). CH works to combine data and forward it to the BS after data aggregation operations. In this method, each cluster has an individual ‘CH' to perform aggregation of the combined data received from different other sensor nodes (SN), in the hierarchy of data flow CH node is at the higher level while SN nodes are at the lower level. CH has to perform the data aggregate and data transmission over higher distance to the BS hence requires more energy than other SN. For the load balancing and efficient resource utilization, there is a periodically change in the CH of a cluster, BS is the last processing point of the data from various CH.



2.B.1) Low Energy Adaptive Clustering Hierarchy (LEACH):

As CH requires more energy than other SN in a cluster, if the CH changes periodically among all the nodes with fixed system lifetime, these nodes would quickly utilize their limited energy. If the CH runs without energy, it loses communication with BS and does not perform longer operations.

[16] Wendi B. Heinzelman (2002) developed and analyzed "Low Energy Adaptive Clustering Hierarchy" (LEACH) architecture for a network protocol to combine the energy-efficient cluster routing and Media Access Control (MAC) with application-specific DA. LEACH performs a randomized selection of high-energy node as a CH among the sensors to avoid the above-stated problem. LEACH is a distributed cluster formation approach that provides self-organization of large numbers of nodes, algorithms for adapting clusters and appointing CH to every cluster for balancing the energy load among all the nodes, and method to enable distributed signal processing to save communication resources. The objectives are to achieve good performance in system lifetime, latency, and application perceived quality. The conclusion shows the improvement in system lifetime by an order of magnitude compared with general-purpose multi-hop approaches.

2.B.2) Power-Efficient Gathering in Sensor Information Systems (PEGASIS):

The LEACH protocol presented a simple and effective solution where clusters are formed with a distributed cluster formation approach and random selection of high energy node as CH among available sensor nodes in a network. The data transmission from each SN to CH and CH to BS required more energy.

[17] To overcome the problem of high energy consumption and dynamic cluster formation, Lindsey & Raghavendra (2002) simulated 'PEGASIS: Power-Efficient Gathering in Sensor Information Systems' that arrange sensor nodes in a chain-like structure for the DA. PEGASIS is an improvement over LEACH. Here, simulations show that it performs better than LEACH by about 100 to 300% according to the number of nodes die for different network sizes and topologies. Two notable drawbacks also observed, i) to form a proper chain, it requires each SN to have a complete view of the network topology also capability of all nodes for transmission directly to the BS, ii) distances between SNs are too long, the energy consumption can be significantly high.

2.B.3) Energy-Efficient Mobile Sink Routing Protocol (EEMSRA):

[19] Xun-Xin and Rui-Hua (2011) demonstrated "An Energy-Efficient Mobile Sink Routing Algorithm for Wireless Sensor Networks" (EEMSRA) in which extended LEACH with Random Waypoint Mobility Model, Mobile Sink Routing Schedule Model and Mobile Sink Routing Protocol for the energy-efficient and energy balanced approach in WSN.

LEACH is popular routing algorithms for WSN which effectively maintain the energy consumption of sensor nodes by involving them in multi-hop communication. LEACH is a cluster-based data aggregation method, which randomly selects sensor nodes as CH and uses them as routers to the sink. After the predefined period, CH changes randomly to balance the energy consumption of nodes. After the formation of the clusters, the CH creates a TDMA schedule for informing SN to transmit data to them. The CH performs DA of received data from various SNs and transmits this aggregated data to the sink.

2.B.4) Hybrid Energy-Efficient Distributed Approach:

[20] Younis and Fahmy (2004) demonstrated "Hybrid Energy-Efficient Distributed clustering approach" (HEED) which is a distributed energy-efficient clustering approach which periodically selects CHs according to a hybrid of the node residual energy and a secondary parameter, i.e. node proximity to its neighbors or node degree. HEED extended the improvement in network lifetime, scalability, fault tolerance and supports to the load balancing.

Here, the process must be to identify a set of CHs which cover the complete field. In effective-cluster formation, each node must be mapped to exactly one cluster, which independently takes decision based on only local information. Clustering ends within a fixed number of iterations, it is efficient in terms of processing complexity and message exchange and CHs are well-distributed and contains high average residual energy than regular nodes.

In the comparison of HEED with a Generic Clustering (GC) protocol, it is observed that:

1) The number of iterations required for the clustering process in HEED is approximately half.
2) The average number of CHs selected by both GC and HEED is almost identical.
3) The CHs selected by HEED required high residual energy, and their average residual energy is not far lower than that with GC.
4) HEED produces a higher percentage of non-single-node clusters.
5) In the operations of HEED, node synchronization is not critical.
6) The average percentage of CHs is much lower in the non-uniform case than in the uniform case.

V. Conclusion

IoT with number of sensor nodes has limited sensing, computational, and communication capabilities. The network efficiency totally depends on the above defined characteristics. Due to such limitations, the data size should be lower weight to improve the efficiency of the sensor nodes and bandwidth utilization of a network. In today's IoT era, day to day use of wireless sensor network is increasing. Data Aggregation helps to achieve network efficiency by avoiding data redundancy.

The routing algorithms perform major role for WSNs. Here, we have analyzed sixteen different methods based on their Redundancy, Latency, Computation Overhead, and Data Accuracy. From analysis it is concluded that, all algorithms have their own set of advantages and limitations. Improvement of one parameter may results in lowering of other. For example, increase of data aggregation level causes improvement of network lifetime but it may also causes increase of network delay. Thus, algorithm selection for Data Aggregation is completely application specific. As per application requirement suitable algorithm should be selected.

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