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A Study of Machine Learning in Wireless Sensor Network

Zaki Ahmad Khan
College of Life Science, Nanjing Agricultural University, Nanjing, China.
t2016041@njau.edu.ac

Abdus Samad
University Women's Polytechnic, Aligarh Muslim University, Aligarh, India.
abdussamadamu@gmail.com

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Abstract – Within this Paper, a concept of machine learning strategies suggested. In this investigation to address the design issues in WSNs is introduced. As can be viewed within this paper, countless endeavors have induced up to now; several layout issues in wireless sensor networks have been remedied employing numerous machine learning strategies. Utilizing machine learning based algorithms in WSNs need to deem numerous constraints, for instance, minimal sources of the network application that really needs distinct events to be tracked as well as other operational and non-operational aspects.

Index Terms – Wireless Sensor Network, Machine Learning, Supervised Machine Learning, Unsupervised Machine Learning.

1. INTRODUCTION

Nowadays physical environment incorporates massive and varied information options, for instance, seismic waves, motion, light, temperature and so on. It is necessary to acquire the information from numerous varied options for a greater comprehension of the environment as well as the wireless sensor network (WSN) is a simple to employ infrastructure enabling getting this kind of abundant information. The WSN's includes spatially dispersed autonomous sensors to monitor the physical environment also to co-operatively cross their data via a network to a primary node or perhaps base station. Contemporary, WSN's are bi-directional, enabling transmission of information staying tracked from nodes to central node or base station, along with allowing control over sensor activity from the base station to sensor [1]. The progression of WSN's was encouraged mainly by military applications for instance battlefield surveillance; at the moment this kind of networks are employed in several commercial as well as buyer applications such as commercial method tracking and also handle, machine health tracking, environmental detection and habitat tracking. The WSN is created of nodes by several various enough nodes which known as motes, in which every node is connected to a single sensor. Every this kind of sensor network node offers generally many components: a radio transceiver with an inner antenna or even link to an outer antenna, a microcontroller, an electronic circuit for interfacing with the sensors and a power resource, usually a battery or an embossed kind of energy Harvesting. A sensor node may vary in dimensions from that of a shoebox down to the size of a grain of dust, while functioning "motes" of genuine microscopic dimensions possess however to be made. The expense of sensor nodes is likewise variable, ranging from several to a lot of bucks, based on the intricacy of the specific sensor nodes. Size and cost restrictions on sensor nodes lead to related restrictions on assets for instance energy, memory, computational speed and communications bandwidth. The topology of the WSNs may vary from a basic star network to a higher level multi-hop wireless mesh network [2, 3]. The propagation method between the hops of the network may be decided influenced by routing or flooding protocol. A WSN's can be used for various applications; we can summarize some of the useful applications such as Habitat/Area monitoring, Environmental/Earth monitoring, Critical Events/Forest fire detection and Data Logging.

An extensive range of applications starting from ecosystem monitoring to battlefield surveillance can be benefited by deploying the WSN's technology. Some of the benefits include low cost, easy deployment, high fidelity sensing, and self-organization of WSNs, among several other benefits. However, despite many opportunities the wireless sensor networks provide, using WSN technology comes with great challenges [4, 5]. These challenges are associated with characteristics of wireless sensor networks namely:

- The energy ingesting limitations to nodes using batteries or energy harvesting.
- The Capability for handle with node fiascoes.
- The Nodes mobility.
- The Communication fiascoes.
- Scalability to development of a large scale.
- Facility for endure punitive ecological situations.

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The paper is prearranged as follows: In section 2 presents machine learning strategies. Section 3, related work for machine learning on WSNs is carried out. The operational and Non-operational issues are discussed in section 4 & 5. The specific application issues are discussed in section 6. In section 7, the WSN's rift on machine learning is described. Finally, section 8 concludes the paper.

2. MACHINE LEARNING STRATEGIES

The current improvements in Machine Learning (ML) and soft computing strategies enable more beneficial prophecy models to be created based on a set of dimensions. The learned model might be merely a basic parametric function, learned from data, a couple of input variables-usually traditional dimensions or point of view, allowing output state or variable to be expected precisely. The WSN's can include heterogeneous, numerous autonomous, inexpensive as well as minimal power sensor nodes.

The intent behind these types of nodes would be to collect data about the physical environment being tracked and merge together for ahead felt data to centralized control units known as base station nodes or sink nodes for additional processing. The sensor nodes in the WSN might be heterogeneous which is became designed with numerous kinds of sensors like thermal/temperature. The WSN creators have to deal with many issues regarding for aggregation or assortment of data, data reliability, clustering of nodes, security & fault detection [6, 7].

In the late 1950s, the ML was originally launched as a unique method for Artificial Intelligence (AI). It's concentrated gradually moved and also developed extra towards algorithms which are computationally achievable and compelling through the years. The application developed widely in recent years in many areas such as spam detection, bioinformatics, speech recognition, as well as fraud detection [8]. The epitome of machine learning could be caught by following two traditional definitions:

- The learning processes for development of computer models that can enhance the performance of systems and offer methods to the issue of information acquisition.
- Detecting & describing consistencies and patterns in training data by employing computational methods that can improve machine performance.

Machine learning technology seems extremely encouraging according to these definitions for address issues in WSNs because it permits applying traditional data to develop the efficiency of a network on presented task, or even forecast the upcoming efficiency. For WSNs, utilizing machine learning technology could be enormously good for numerous causes such as:

- Excellent tracking of dynamic environments that modify swiftly with time. As an illustration, in soil tracking scenario, it can be possible that the location of sensor nodes may modify because of soil abrasion or ocean turbulence and WSN depending on machine learning can enable automated adaption and economical operation in such dynamic environments.
- Offering computationally possible, low-complexity mathematical models for complex environments. In these environments, it is not easy to develop precise mathematical models, and also difficult for sensor nodes to calculate the algorithm reminiscent of these types of mathematical models. Under such type of situations, WSN influenced by machine learning strategies can provide low intricacy approximations for the system models, enabling its implementation within sensor nodes.
- Augmented automation and novel applications improvement, for instance regular, ambient computing systems. WSN based upon machine learning can enable boost automation and new utilizes by integration along with other WSNs causing completely sensored huge applications for instance IOT technologies, CPS and m2m communications. These kinds of applications utilize several unique kinds of WSNs and if influenced by machine learning. Nevertheless, it is relatively feasible that WSN depending on machine learning strategies may not lead to any upgrades if a few of the problems laid out below are not regarded during the design stage.
- As the WSN environment is an asset minimal, important energy is burned on foretelling the hypothesis with precision, and also for worldwide event detection kind scenarios, energy-efficiency, and prediction precision is basically a trade-off.

Lately, a growing usage of machine learning technologies in automation of WSNs operations has been experienced. The present an excellent study of machine learning strategies used on WSNs to handling the information in the network and increases the performance of network. A comparable study, however, more concentrated towards ad-hoc networks and how machine learning techniques have been implemented in ad-hoc networks is introduced in [9]. An additional seminal work on applications of three widely used machine learning algorithms whatsoever communication levels in the WSNs is introduced in [10]. A few of the work also resolved particular issues in WSNs for instance authors in, who created an effective outlier diagnosis strategy based on machine learning principles. Authors in offered a strategy depending on computational intelligence technique for dealing with issues corresponding to data aggregation.

Many of the previously focus on utilizing machine learning methods for WSNs highlighted reinforcement learning, neural

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networks and decision trees that were more developed in their reputation of being economical at a conceptual level and implementation level [10]. A few of the machine learning algorithms to deal with functional or operation issues in WSNs such as aggregation of data, clustering, routing, localization, processing of query as well as medium access control. The operational or functional issues are those issues that are important for the simple operation of WSNs [11, 12]. After that, there are certain strategies that have addressed the non-operational on non-functional in WSNs, for instance, those that figure out the quality or improve the efficiency of functional components, QoS, security and integrity of data. The present an extensive analysis of a few of the relevant methods wherein machine learning technology has been used for WSNs which can also represent a style primer and relative manual.

3. BACKGROUND ON MACHINE LEARNING FOR WSN's

There are three kinds of Machine Learning Techniques are presented below:

3.1 Supervised Learning

The system model is built with labeled training set is knows as outputs and predefined inputs in the supervised machine learning. The learned relationship between output, input and parameters of the system is learned by system model. This type of learning approach is used to resolve various issues for WSNs such as objects targeting & localization, processing of query and event detection, medium access control, intrusion detection and security, data integrity and QoS [12]. The few supervised machine learning algorithms are discussed below.

3.1. 1 Decision Trees

The decision tree classification involves predicting output labels by repeating input of data using tree of learning. Through the iterative procedure, a comparison of feature possessions virtual to decision situations is done for spread a particular category. A significant amount of research was done in using decision trees to address different design challenges in WSN such as identifying link reliability in WSNs using decision trees [13]. Here the use of decision trees offers a general tactic for recognize critical features for link reliability including loss rate, Restore Mean Time as well as Failure Mean Time.

3.1.2 Support Vector Machines

Support Vector Machines offer alternatives for neural networks that are preferred options for solving nonconvex unconstrained optimization problems. In the context of WSN, they have been used for intrusion detection or detecting the malicious behavior of sensor nodes, security, and localisation. With SVM, it is possible to uncover the spatio-temporal correlations in data, as the algorithm involves constructing a set of hyper planes separating WSN data measurements in feature space, by as wide as possible margins [12, 13].

3.1.3 Neural Networks

Neural networks are one of the most popular learning algorithms for learning from data and can built with the help of decision units cascading chains often called perception & radial basis functions. The cascading chains of decision units allow recognitions of non-linear and complex relationships in data. However, the learning process with multiple cascading chains is highly computations intensive [13, 14].

3.1.4 K-nearest neighbour (k-NN*)*

The K-NN is supervised learning algorithm and in this learning algorithm, a test sample data is classified based on the labels of nearest data samples. By computing an average of readings within its neighborhood, the missing or unknown test sample measurement is predicted. Determination of a nearest set of nodes is done by using different methods [14]. One of simplest method to determine the neighborhood is by using the Euclidean distance between different sensors. As the distance measure is computed using few local points with k normally a small positive integer, the k-NN approach does not need high computational power. Due to its simplicity, the k-NN algorithm is suitable for query processing tasks in WSNs.

3.1.5 Bayesian Learners

While most of the machines learning algorithms require a large number of training samples to learn, learning techniques based on Bayesian statistics require lesser training samples. The learning happens in Bayesian methods by adapting the probability distribution to efficiently learn the uncertain labels [15, 16]. The important aspect of this learning technique is, it uses the current knowledge (that the collected data samples (D)) to refine values of prior belief into posterior belief values Equation 1.

$$(\theta|D)\alpha(\theta)*p(D|\theta) \quad \ldots\ldots\ldots (1)$$

Where $(\theta|D)$ = posterior probability of the parameterθ, assumed observation D.

And $(D|\theta)$ = prior probability of analysis D, assumed the parameterθ.

In WSNs, these types of Bayesian learners are useful for assessing event consistency (θ). By the employing of (D) which is known as sets of incomplete data from examining prior information regarding environment. Several variations of Bayesian learners allow better learning of relationships, such as Gaussian Mixture Models, Dynamic Bayesian Networks, Conditional Random Fields as well as Hidden Markov Models.

3. 2 Unsupervised Learning

For unsupervised learning, there are no labels provided or there is no output vector. The sample set is classified into distinct

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sets by checking out the likeness between these with an unsupervised learning algorithm. This type of learning algorithm finds use in WSN node clustering or data aggregation at sink code scenarios. With no labels provided, the unsupervised machine learning algorithm discovers the hidden relationships and is suitable for WSN problems, with complex relationships between variables [14, 16]. Two most important types of algorithms in this category are K-means clustering and Principal component analysis.

3.2.1 Principal Component Analysis

This learning algorithm is quite popular into data compression field and is used for dimensionality reduction. It is a multivariate method and aims to extract important information from data in terms of principal components, which is nothing however a set of new orthogonal variables [17].

The data compression and dimensionality reduction is a multivariate method. It's objective extract crucial information from data. Also, it as a couple of new orthogonal variables knows as principal components. These principal components are ordered such that the first principal component is aligned in the direction of the highest-variance path of data, with reducing variation for additional components in order.

This permits, the minimum variance components to be abandoned as they simply include least information content, causing dimensionality decrease. For WSN situations, this could lower the quantity of data becoming transmitted among sensor nodes by getting a tiny pair of uncorrelated linear blend of innovative readings. Further, it can solve the big data problem into small data by allowing selection of only significant principal components and discarding other lower order insignificant components from the model.

3.2.2 K-Means Clustering

This unsupervised learning algorithm classifies data into different clusters or classes and works in sequential steps involving, random selection of k nodes as initial centroids for different clusters, use of a distance function to instructions every node with the nearest centroid, iteratively re-compute the centroids using a predefined threshold value on present node memberships and quit the iterations if the convergence condition is met [17]. The K-means clustering algorithm is popular in WSN sensor node clustering because of the simplicity and linear in its complexity.

3.3 Reinforcement Learning

This type of learning algorithm for WSNs involves learning by interaction with the environment. Here, a benefits process is involved and a sensor node learns to seize ideal measures to ensure that the lasting advantages get maximized with experience. The Q-learning is most well-known reinforcement learning algorithm useful algorithm for WSN routing problems in which each one node tries to select measures which are anticipated to increase the extended benefits. Here, the sensor node in Q-learning regularly updates the rewards it achieves based on the action it takes at a given state [16, 17, 18]. The computation of future total reward also known as Q-value of performing an action at a given state is obtained using Equation in 2 as:

$$Q(st+1,\alpha t+1)=Q(st,\alpha t)+\gamma(r((st,\alpha t)-Q(st,\alpha t)) \quad \ldots\ldots(2)$$

Where (,) indicates the instant incentive of performing an motion at a particular statest, andγ is the understanding rate that decides how rapidly understanding happens (generally pair to value between 0 and 1).

4. OPERATIONAL ISSUES

There are numerous operational or functional issues in the design of WSNs, for instance, energy and memory constraints of sensor nodes, topology transforms and communication connected downfalls and decentralized management. These types of operational issues can be resolved from consuming machine learning paradigms in the methods of the WSNs work.

4.1 Issues of Query Processing and Event Recognition

The event recognition and query processing are vital operational needs of large scale WSNs. The functionality required following is a legitimate event scheduling and recognition with nominal human involvement. Normally, WSN tracking categorized as an event-driven. With machine learning dependent event monitoring strategy [19]. It is possible to acquire economical event detection and query processing remedies under restricted environment with limited query areas.

Adopting machine learning dependent strategies for these operations can lead to various advantages including:

- Facilitate expansion of effectual event detection techniques using learning algorithms and simple classifiers, particularly with the limited availability of storage and computing resources.
- Facilitate the growth of useful query processing methods for WSNs such as figure out the lookup areas whenever a query is coming from, and localize the communication efforts there, instead of flooding the whole network.

A few of the convenient strategies entail describing a stern threshold value for trend being sensed and triggering alarms for every violation, although latest WSN arrangements utilize much more intricate strategies than employing easy threshold values. The intricate, emerging strategies employed advanced machine learning dependent casting of an issue for event detection and query processing. A number of them are cited below.

- Bayesian Event Detection Algorithm

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- HMM-Bayes Activity Event Recognition
- Principal Component Analysis (PCA) for Query Optimization:

4.2 Issues of Medium Access Control (MAC)

There are plenty of issues in the design of MAC protocols for WSNs, for instance, power intake, latency, and forecast precision etc., along with fundamental operational characteristic that plethora of sensors cooperates to effectively transfer data. Consequently, the MAC protocols need to be designed correctly to enable economic data transmission as well as coverage of the sensor nodes [19, 20]. Lately, a number of machine learning strategies also has been suggested for designing suitable MAC protocols as well as increasing the performance of WSNs. In these works, machine learning performs a role in numerous methods including:

- Employing the communication background of the network to adaptively determine the accountability sequence of a node. Here, which are effective at predict although the other nodes transmissions are going to carried out, can slumber in the meantime and stand up simply although the station is expected to be best without any extra node is transmitting.
- Using the concepts of secured data transmission along with machine learning in designing the MAC layer protocol. Such a secure MAC layer scheme would be independent of the proposed application and can learn sporadic attack patterns, iteratively.

A short explanation of how the WSN protocols design issues were resolved by machine learning along with relevant strategies are enumerated below.

- MAC design using Bayesian Statistical Models
- MAC design using Neural Network Models
- MAC design using Reinforcement Learning Models
- MAC design using Adaptive Decision Trees

4.3 Issues for Routing in WSN

While the sensor nodes possess restricted processing features, compact memory, and lower bandwidth, designs a routing protocol for WSNs needs to deem numerous design issues, for instance, energy consumption, fault tolerance, scalability, and data coverage. The composition of a routing issue in wireless sensor networks customarily is conducted as a graphing issue G = (V, E), where V shows the pair of all nodes and E represents the pair of bidirectional communication channels linking the nodes [20, 21]. Using this graph modeling strategy, the routing issue can be called the process of getting the minimal cost way from the source vertex to all destination vertices, by utilizing the available graph edges. A few of the positive aspects can be potted as cited below:

- Learn optimal routing paths which can lead to energy effectiveness as well as extend the lifespan of dynamically altering WSNs.
- Divide intricate routing issue into convenient sub-routing issues, where the nodes in the sub issue generate the graph structures, by contemplating merely their local neighbours, and attaining low economical and real time routing.
- Employ uncomplicated computational approaches and classifiers, and meet Quality of Service (QoS) requirements in routing problems.

An overview of various WSN routing protocols which have employed machine learning dependent strategies is enumerated below.

- Distributed Regression Approach
- Self-Organizing Map (SOM) based data routing approach
- Reinforcement

4.4. Issues Allied to Object Targeting and Localization

The procedure of determining geographic coordinates of network's nodes is known as localization and location awareness of sensor nodes in WSNs is a crucial ability. Usage of GPS hardware in every node of WSN, however, can supply location consciousness it not possible cost wise. Additionally, GPS services are probably not obtainable in noticed remote and particular indoor locations. Furthermore, GPS service is probably not accessible in the identified environment. Further, by applying proximity dependent localization [22]. These distance capacities could be computed by various strategies for instance Received Strength Signal Indication, Arrival Time and Arrival Difference Time. Additionally, particular angular measurements are available by utilizing compasses or even unique smart antennas. Some appropriate strategies suggested by scientists for WSN localization using machine learning strategies.

- WSN node localization using Bayesian approach
- Location Aware Bayesian approach for Activity Recognition
- Neural Network based WSN Localization Approach
- Support Vector Machine (SVM) based WSN Localization Approach
- Light Weight Support Vector Regression (LWSVR) based Localization
- Localization using Decision Trees

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- Localization using Gaussian Processes
- Localization using Self-Organizing Map (SOM)
- Reinforcement Learning based Localization

4.5 Issues of Clustering and Data Collection

This really is inadequate to transfer entire data for sink instantly to large scale energy-constrained sensor networks. A renewable efficient strategy should be to cross the data to an intermediate cluster head which is also introduced local data collectors which accumulates data by entire the sensors into. It is a cluster as well as forwards it for sink node or the base station node [23, 24]. Determined by how the cluster head selection or election is conducted, you can attain considerable energy savings. Because of this, numerous algorithms are actually suggested for cluster head selection/election to increase the energy efficiency. The machine learning dependent strategies can develop the advantages of clustering and data collection mechanism between nodes in WSNs in numerous ways for instance:

- Identify non-functional nodes and remove them from routing schemes, using machine learning algorithms, which can compress data locally at cluster heads, with dimensionality reduction techniques, that extract similarity, and dissimilarity in different sensors' readings.
- Identify (select or elect) appropriate cluster head that can maximize energy efficiency and increase the lifetime of WSNs with an appropriate feature ranking and feature selection approaches from machine learning field.

5. WSN'S NON-OPERATIONAL CHARACTERISTICS

While the operational challenges are directly associated with basic operational or functional behavior of systems with WSN, the non-operational aspects are not associated with basic operational needs of system, and though non-functional, are highly desirable, performance enhancing requirements that can use by vendors for differentiating and achieving a competitive edge in the market. Some of the performance enhancing requirements could include updates and analytics on the environment being monitored by WSNs, Quality of Service, security, and data integrity. Recent advances in machine learning techniques can be harnessed to address the non-operational aspects and enhance the WSN performance. Some of the work reported in this area is discussed next.

5.1 Anomaly Intrusion Detection and Security

Because of restricted resource needs, security and intrusion management strategies are challenging to implement in WSNs. Earlier, some of the techniques influenced by machine learning are already suggested for intrusion detection entail prolog of anomaly or unexpected, unreliable studies to the network and emulating a mugging situation. At this point, the data is categorized into two classes corresponding to most studies that may remain in these two areas however the measurements which are sporadic and also uncommon due to presumed attacks are considered as anomalies or intrusions [25, 26, 27]. Detection of outliers and unreliable measurements can be achieved by various machine learning algorithms, such as supervised, unsupervised and reinforcement learning algorithms by studying renowned malicious activities and vulnerabilities, numerous attacks and intrusions can be detected. This kind of WSN security enhancements by using machine learning strategies can lead to numerous advantages including:

- Preventing the transmission of anomalous and suspicious data, by detecting outliers, save WSN node energy, and significantly expand WSN lifetime.
- Eliminating faulty and malicious readings, and avoiding the discovery of unexpected information impacting on the critical actions, so as to enhance the WSN reliability.
- Prevention of malicious attacks and vulnerabilities, by automatic online learning and prevention of malicious attacks and vulnerabilities.

Some of the approaches based on machine learning, addressing the security issue in WSNs are given below.

- Outlier detection
- Anomaly detection

5.2 Quality of Service Enhancement & Data Integrity

The WSNs agonize with bandwidth and power constraints that can restrict the amount of information which can be conveyed from a source to destination node. Additional, due to random network topologies, faulty, unreliable data aggregation or dissemination in WSNs, Quality of Service (QoS) guarantees are necessary.

The QoS enhancements guarantee of real-time events and data with high priority delivery [25]. Few of current efforts on using machine learning schemes to attain exact data integrity and QoS metrics determine various benefits such are specified below

- Use of machine learning approaches can eliminate the need for flow-aware and stream-aware management techniques, as they can be trained to recognize different types of streams automatically.
- Using Neural Networks for QoS estimation
- Learning Based Quality Estimation Framework
- Use of Multi Output Gaussian Processes for WSN node Accuracy and Reliability Assessment
- QoS guarantee based on reinforcement learning

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6. APPLICATION SPECIFIC UNIQUE CHALLENGES

There are certain unique application particular challenges which can't be classified as popular machine learning WSN literature. But, are exclusive as well as give insight into how certain unfortunate facets of WSNs were resolved. A few of these are succinctly mentioned below.

6.1 Self-Organizing Map Modeled Clock Synchronization

While the contemporary WSN nodes need to carry out various tasks until restricted resources, clock synchronization between sensor nodes is a crucial necessity to sustain persistence in signatory of tasks between the sensor nodes for large scale WSNs. The nodes can foretell the close to an optimal approximation of present time without a usage for middle timing device with limited storage as well as computing resources. Nevertheless, presumes that the nodes are implemented uniformly over the tracked area and virtually all the nodes possess identical transmission powers that are not invariably the case.

6. 2 Neural networks Modeled Intelligent Lighting Control

The Radial Basis Function neural network was accustomed for removing a computational thing known as Illuminance Matrix for determine level of illuminance in the lighted area. It is quite a distinctive application area which application field possesses various challenges concerning transforming the identified data from photo sensors to a quantitative or qualitative aspect which can prepare by computers and can consequence the efficiency of the system significantly.

6.3 Reinforcement Learning for WSN Resource Management

An algorithm which exploits the local information and restrictions enforced on the WSN application to maximize numerous tasks during a period of time although increasing power efficiency. With this algorithm, referred to as Distributed Independent Reinforcement Learning, each WSN node discovers the minimal needed resources to carry out its routine tasks with benefits allocated by Q-learning technique. The Q-learning modeled DIRL algorithm can enable studying of task a priority for a particular task routine of the application. The object monitoring application that includes five various tasks for instance enumerated below:

- Readings collection more than two on a single reading
- Transmission message for next hop
- Incoming messages receipt
- Reading of next sample
- Node placing on sleep mode

These kinds of tasks ought to be carried out in some concern for increasing the lifespan and WSN lacks a preset routine for attaining this efficiency objective. Under this kind of situations, Q-learning based DIRL task scheduler can understand fees as well as rewards assigned for wrong/right decisions during learning stage and can perform better in real time based on this knowledge.

7. WSN's RIFT ON MACHINE LEARNING STRATEGIES

The work exists in using machine learning strategies for addressing numerous challenges in WSNs, comprised operational, non-operational and application specific challenges. But, there is still rift, and there is a requirement for further research works as many issues are still open and need to be solved. Some of the rifts and further research work required are discussed below:

7. 1 Managing Resources Using Machine Learning

The WSN designers deal with various kinds of challenges, such as operational, non-operational and application precise challenges. The Energy efficiency is among crucial challenge and energy saving design aim can be done employing enhancing operational features for instance improved communication restrictions and by detecting non-operational, energy inefficient actions, for example, hearing neighbouring nodes, transmitting unnecessary information, by being in lively listening mode constantly.

7.2. Distributed & Adaptive Machine Learning Strategies for WSNs

As a consequence of WSN sensors being devices with minimal sources, distributed machine learning strategies are required for WSNs compared to centralized learning algorithms. It will enable fewer computational energy needs as well as lesser memory impact. Additionally, the algorithms should be adaptive, enabling nodes to understand present environment problems as well as swiftly adapt their future tendencies and estimations dynamically. Therefore, adaptive and distributed learning algorithms are required for minimizing the communication expenses and also relieve the computational load on the nodes.

7. 3 Methods for Selecting Sensors

The various sensor measurements are required in practice to maintain the event and sustain desired detection accuracy. The necessity for WSN nodes to operate under resource constraints, network designers deal with numerous design challenges, matching network management and communication bandwidth. The eighty percent of the energy in the sensor nodes is used for interaction activity. The useful data compression and dimensionality drop techniques are necessary to decrease transmission lessen as well as therefore prolong the network lifetime.

8. CONCLUSION

In this paper, we have discussed the operational and non-operational issues in many aspects as well as WSN rift on machine learning strategies. With the help of this study, we can

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designed integrated framework, which takes into consideration both operational, non-operational and application-specific challenges to address the WSN challenges namely integrated framework for energy efficient WSN based on machine learning.

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Authors

Dr. Zaki A. Khan is currently working as a Postdoctoral Research Fellow in Nanjing Agricultural University, Nanjing, China; He has done Ph.D. from Aligarh Muslim University Aligarh, India. He received Msc.Tech (Industrial Math's with Computer Applications) and BSc (H) Mathematics degree from Jamia Millia Islamia New Delhi, India in 2010 and 2007 respectively. The research areas are parallel & distributed systems, Genetics Algorithm, Scheduling & Load Balancing, Information Retrieval, WSNs, Multiprocessor System and Green Computing. Contributed and attended national & International conferences and workshops. He has published various research papers in reputed International journals that are indexed in Scopus, IEEE Xplore, Springer, and SCI. Member of CSTA, IAENG, IACSIT and UACEE. He has received young scientist award by department of science & technology (DST), India in 2015.

Dr. Abdus Samad received his Ph.D. degree in Computer Engineering from Aligarh Muslim University, Aligarh, India in 2010. He completed B.Sc. Engg and M.Tech. From Z. H. College of Engineering & Technology, Aligarh Muslim University, Aligarh in the year 1997 and 1999 respectively. The research areas are parallel and distributed systems, algorithm design, microprocessor and parallel system design. Contributed and attended various national and international conferences in India and abroad, & published papers in reputed journals. Member of various professional organizations. Presently working as Associate Professor in Computer Engineering at University Women's Polytechnic, AMU, Aligarh and having teaching experience of more than 18 years.