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Study and Review of Energy Optimization Techniques of WSN Based on Machine Learning

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ABSTRACT
Wireless sensor network (WSN) systems are typically composed of thousands of sensors that are powered by limited energy resources. To extend the networks longevity, clustering techniques have beenintroduced to enhance energy efficiency. The Existing protocols are analyzed from a quality of service (QoS) perspective including three common objectives, those are energy efficiency, reliable communication and latency awareness. Understanding the user's requirements is critical in intelligent systems for the purpose of enabling the ability of supporting diverse scenarios. User awareness or user- oriented design is one remaining challenging problem in clustering. Therefore, the potential challengesof implementing clustering schemes to Internet of Things (IoT) systems in 5G networks. As the current studies for WSNs are conducted either in homogeneous or low-level heterogeneous networks, they are not ideal or even not able to function in highly dynamic IoT systems with a large range of user scenarios. Moreover, when 5G is finally realized, the problem will become more complex than that in traditional simplified WSNs. But when WSN grows, the volume of data to be gathered processed and disseminated by the sensor nodes increases largely. Processing and transmitting such a large amount of data is impractical because of the limited energy of the sensors. Thus, there is a need for applying Machine Learning (ML) algorithms in WSNs. Several challenges related to applying clustering techniques to IoT need to be analyzed along with machine learning techniques to optimize the performance of WSN.

Keywords
WSN, Machine learning, Energy Optimization.

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I. INTRODUCTION

The real-world physical environment consists of large and diverse information sources, such as light, temperature, motion, seismic waves, and many others. For a better understanding of the environment, it is necessary to capture the information from multiple disparate sources, and the wireless sensor network is an easy to deploy infrastructure allowing capturing of such rich information. A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor the physical environment, and to co-operatively pass their data through the network to a main node or central location (base station). Modern wireless sensor networks are bidirectional, allowing transmission of information being monitored from nodes to central node or base station, as well as enabling control of sensor activity from base station to sensors. The development of wireless sensor networks was motivated primarily by military applications such as battlefield surveillance; but today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, environmental detection, and habitat monitoring. The WSN is built of ”nodes” from a few to several hundreds or even thousands of nodes (sometimes called as motes), where each node is connected to one (or sometimes several) sensors . Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning “motes” of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSN scan vary from a simple star network to an advance multihop wireless mesh network. The propagation technique between the hops of the network can be determined based on routing or flooding protocol . A wireless sensor network can be used for various applications; we can summarize some of the useful applications as the following [3]

1.1.1 Habitat/Area monitoring: Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors to detect enemy intrusion; a civilian example is the geo fencing of gas or oil pipelines. When the sensors detect the event being monitored (heat, pressure), the event is reported to one of the base stations, which then takes appropriate action (e.g., send a message on Internet or to a satellite). Similarly, wireless sensor networks can use a range of sensors to detect the presence of vehicles ranging from motorcycles to trains and cars.[2]

1.1.2 Environmental/Earth monitoring: The term Environmental Sensor Networks has evolved to cover many applications of WSNs to earth science research. This includes sensing volcanoes oceans, glaciers and forests.

1.1.3 Critical Events/Forest fire detection: A network of sensor nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. Early detection is crucial as it will allow protection of highly valued resources.

1.1.4 Data Logging: Wireless sensor networks are also used to collect data for monitoring information from the environment. For example, monitoring the temperature in a fridge to the level of water in over flow tanks in nuclear power plants.[1]

1.2. Energy Consumption in Transmission

The sensor nodes sense the information and provide analog signal as output after sensing information. Inthe node various operations has been done that are filtering, amplification and digitalization. After this process data has been delivering in the form of packets using the transmitter that has been used for transiting the information from source to destination. Transmitter circuit of the network has been used for packet transmission that enables the route addresses checking process of the sensor node. The signal level needs to be amplified before reaching the antenna and propagated through a dispersive medium, such as water or air (which does not generate as many losses as water). This guarantees an acceptable signal level at the receiver input. In addition, adequate modulation techniques should be implemented in order to minimize the loss of information. The inverse system is implemented at the receiver node. The first stage is an amplifier or attenuator that sets the input level at the receiver circuit. The receiver applies the appropriate demodulation to obtain the original bit sequences, which are interpreted by the node. Each of these stages involves electronic circuits that generate a considerable level of energy consumption. The distance between transmitter and receiver must also be taken into account in order to calculate the overall power dissipation. A first, obvious measure consists of adjusting the transmission power to the characteristics of the propagation path, like attenuation and range. Other more sophisticated techniques can be used, like preventing the duplication of packets in the network by using specialized routing protocols. A frequently used approach is to control the node activity, switching the operation mode between active, idle and sleep modes. The processor consumes the most amount of energy in the active mode. In this mode the device can receive and send data and control packets and can perform data processing. In sleep mode, a device consumes the least amount of energy as the transmitter is turned off, the frequency of the main processor may be reduced and it is not possible to realize any processing operation. [5]

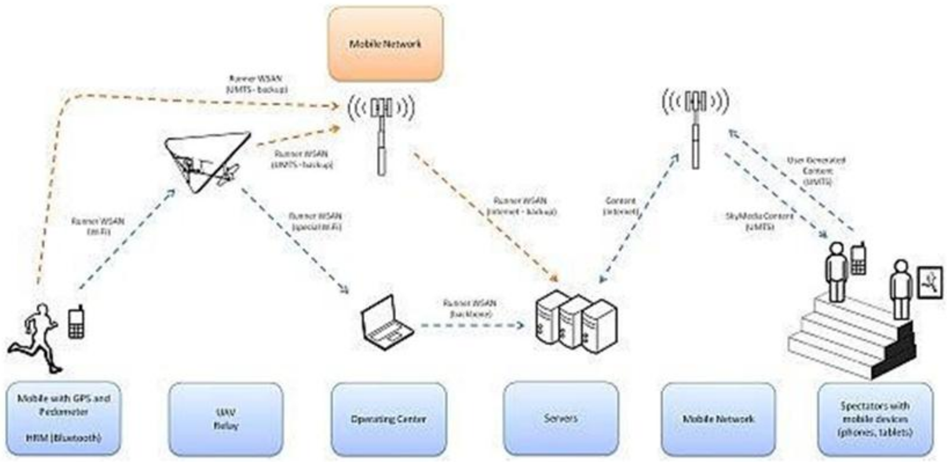

Fig. 1 Wireless Sensor Network structure

II. Literature Review

II.1 Anupkumar M Bongale et al "EiP-LEACH: Energy influenced Probability based LEACH Protocol for Wireless Sensor Network" Design and development of energy efficient routing protocols for Wireless Sensor Network (WSN) is one of the active research fields. Cluster based routing protocols have proven to be energy efficient and LEACH is one of most popular cluster based routing protocol for WSN. But, LEACH suffers from several drawbacks such as possibility of choosing a low energy node as Cluster Head (CH), non-uniform distribution of CHs, etc. In this paper EiP-LEACH (Energy influenced Probability based LEACH) protocol is proposed which is an enhanced version of LEACH protocol thatis influenced by the energy parameter for CH selection.

II.2 Jianpeng Du et al "A Data Collection Approach Based on Mobile Sinks for Heterogeneous Sensor Networks" In wireless sensor networks, the limitation of energy and cache space of nodes around the base station, as well as the multi-hop transmission instability will seriously interfere the performance of traditional data collection protocols. To address this problem, a data collection mechanism by using mobile base station is proposed. Firstly, a new clustering algorithm-Time High-Overflow-Based Dominating (THD) is proposed that the sensor network is divided into several clusters based on sample rate and cache of nodes. Secondly, temporary caching mechanism (TCM) is proposed to further resolve the buffer overflow problem.

II.3 Nabajyoti Mazumdar et al "Distributed Energy-efficient Clustering Algorithm for mobile-sink based wireless sensor networks" clustering is an efficient technique to minimize the energy consumptionof the sensor nodes. But, the clustering algorithms for WSNs with a static sink frequently suffers from uneven energy consumption problems, where cluster heads(CHs) further away from sink consume more energy in a single hop communication, with the CHs sending its data directly to the sink. In order to solve such problem, author proposed a Distributed Energy-efficient Clustering Algorithm for mobile- sink based WSNs, where the sink moves around the target area with a fixed path and speed.

II.4 Abdullah Alomari et al [9] "A Scheme for Using Closest Rendezvous Points and Mobile Elements for Data Gathering in Wireless Sensor Networks" A variety of wireless sensor network (WSN) applications have been proposed. However, the efficiency of WSNs, as well as their ability to interact with different environments, varies. Many challenges and problems to be solved remain. Overcoming these challenges requires a protocol that will design and provide a highly efficient system, thus helping the WSN to transmit data in a suitable time. In WSNs with Mobile Elements (MEs), the task is first to find an effective way to minimize the length of the tour that the ME follows for data gathering.

II.5 Tahar Abbes Mounir et al "Positioning system for emergency situation based on RSSI measurements for WSN" present a technique for indoor localization that uses the results of the Trilateration method and RSSI signal strength to know what is expected in specific locations. Indoor positioning in systems confronts particular problems of precision. This study aims to implement a technical solution that can precisely and efficiently give the position of a target and facilitate the localization of mobile nodes deployed in a given zone. The main objective of this work is to estimate theposition of the node with precision.

II.6 Sharma, N., Singh et al. Because of their vast advancements, which allow the combination of nano-sensors, wireless networks, and smart software, the relevance of WSNs has grown. The main problem with

WSNs is the rapid discharge of sensor energy. Clustering and picking appropriate cluster heads is effective ways to cope with this problem. Mamdani fuzzy rule-base tables is optimized using Fuzzy Shuffled Frog Leaping Algorithm based on specified requirements. Prior to launching network, this method improves five adjustable parameters associated with fuzzy system's intake in offline approach, as well as dynamically modifying if-then rule base. Remaining energy and distance are two inputs to the fuzzy systems. As inputs, fuzzy systems include residual power, proximity from base station and nearby nodes. The recommended clustering technique has two criteria for converting contender nodes into ultimate cluster heads.

II.7 Adnan et al. Network flexibility and energy efficiency are crucial in WSNs. Because WSNs have large no. of nodes with limited storage and batteries capacity, energy-efficient design is essential. Because entire network's life depends on sensor nodes, clustering has been demonstrated to be one of most effective ways for improving energy consumption and network lifetime. To reduce energy consumption and boost network scalability, researchers present multi-hop WSN clustering technique based on fuzzy logic in this paper. Researchers propose CH selection method, where sensor node is chosen as CH based on fuzzy logic inputs. The perimeter size of CHs is likewise determined by the fuzzy. To balance load, researchers pick radius size of CHs based on fuzzy logic inputs. The TTDPF and CHCCF systems are compared to recommended strategy. The simulation findings show that proposed schemes outperform TTDFP and CHCCF schemes in case of network longevity.

II.8 Selvi, M., Kumar, S. S et al Researchers face a significant difficulty in developing energy-efficient routing methods for WSNs. WSNs have lately gained popularity, and there is variety of energy-efficient routing solutions suggested. The bulk of routing protocols focus on CH. Harmony search is used to find initial set of energy-efficient cluster head nodes that are adequately separated from each other by adequate distance. Following that, cluster head nodes are temporarily elected. The firefly approach then refines the cluster that has been provisionally chosen. Firefly approach then streamlines cluster head nodes that have been initially chosen by considering metrics like number of nodes, cluster density, and energy usage. The ch selection is separated into two phases to reduce difficulties due to early converging of evolution optimization approaches. A revised cluster formation approach is proposed in which node has choice of connecting cluster head node depending on either distance-based measure or cluster head remaining energy. Clustering assists in energy conservation. The presented technique is based on assessment parameters like living nodes, energy utilisation, packets collected by BS, First Node Death, Half Node Death, and Last Node Death. When deployed using Simulation Tool, recommended hybrid cluster formation election technique beats specified routing protocols.

II.9 Behera et al. introduced SEP which conducts threshold-based CH selection in non homogeneous network. The energy is divided evenly across CH and other nodes on the basis of threshold concept. On the basis of original power generation, this paper categorised sensor nodes into three classes (basic, intermediary, and advanced) in order to spread bandwidth requirements equitably: According to simulation findings, the proposed system outperforms SEP and DEEC procedures by 30% in network lifespan and 56 % in throughput.

II.10 Mishra, P. K., & Verma et al. discusses compartmental model-based cluster size optimization in wireless networks using opportunistic inputs. Opportunistic data, like Wi-Fi, acoustic, visible light, can be employed based on availability of transmissions in specific region of interest. The compartmental attenuation model illustrates how opportunistic signal power changes with transmission distance. With parameters collected from experimental observations, a theoretical examination of the compartmental model's performance was done. It is discussed how to leverage opportunistic transmissions in compartmental design-based cluster size optimization. When compared to the incremental and log systems, the compartmental architecture improves average power utilization by 6% and 8%, respectively. Both WiFi and acoustic communications are shown to be 13 percent less effective than visible light signals. Future work on recommendation systems, malicious sensor detection and localization, the SGD approach in a large WSN, and the Cramér-Rao constraint for variable prediction will be built on the existing concept.

II.11 Al-Khayyat et al. Based on the ACO approach, a new structure for WSN has been proposed. The K-means clustering technique facilitates secure transmission from a power perspective and also be reliable over a short period of time in Wireless sensor networks of any scale, even without architecture, assistance, or particularly unique nodes, and thus broadens the spectrum of different application fields. The proposed methodology outperformed the Leach clustering method and its variations, such as Fuzzy- leach and other cluster-based algorithms [16], in terms of navigation and power demand.

II.12 Sonam Lata et al FL was used to pick a CH based on three parameters using a new centralised fuzzy-based clustering approach (energy level, concentration, as well as centrality). LEACH creates clusters based on the signal intensity obtained. Similar nodes are added using fuzzy logic and three control dimensions (power capacity, nodal length to Base Station and its radius to cluster head). The authors also employed fuzzy criteria to choose a vice cluster leader, taking into account three variables this time. The first two adjustments are meant to extend the system's life, while the third is made to improve WSN uniformity. The proposed method has been demonstrated to be effective in balancing energy demand at each node, thus improving WSN stability [17].

II.13 Lata et al. Authors introduced LEACH-Fuzzy Clustering protocol and employed centralised technique for cluster head selection. Scholars also used fuzzy logic to choose vice cluster leader, which is another centralised strategy. The suggested approach was found to be effective in balancing energy demand at each node, improving WSN reliability. In terms of network longevity and energy usage, it outperforms previous proposed methods.

2.13 T.Sundararajan and M. Premkuma Many real-time applications are supported by the routers and gateways that are connected to the deployed nodes. WSN faces a security concern as a result of free access. External users can be verified in this situation by establishing authentication, which is required. Many lightweight authentication systems have been developed in real-time applications to achieve safe communication. Because WSNs lack synchronisation between nodes during data routing, they are especially vulnerable to DoS assaults. Deep Learning-based Defense Mechanism is a new lightweight DoS detection system presented in this research to detect and isolate assaults in the Data Forwarding Phase. This study explains how to use a new method to detect DoS assaults like depletion, jamming, homing, and flooding. Scholars run comprehensive simulation tests to precisely segregate attackers and make the system more resistant to DoS attacks. The results of our simulation suggest that it can achievea high detection rate, throughput, packet delivery ratio, and accuracy. This also cuts down on energy use and false alarms.

2.14 Fattoum et al. The energy factor is most important concern in WSN design due to limited capacity of sensor nodes' sources of power. Clustering is well-known strategy for reducing energy consumption in large-scale WSN. This study presents new approach based on fuzzy logic model to extend network longevity. In Steps 1 and 2, fuzzy logic is employed for CH selection, resulting in two-level clustering situation. The proposed model uses similarity variables: similarity variance rate, coverage rate, distance variables: proximity to CH, distance to sink, and remaining energy as fuzzy inference system inputs, to measure spatial correlation of network information. Energy usage and network lifetime extension, innovative fuzzy logic based clustering beats prior schemes and variants of clustering approaches in modeling

III. ENERGY CONSERVATION IN WSN

Energy is very important and center of consideration in developing applications, protocols and any kind of hardware for sensors or for sensor network. Sensor node process can be divided into 3 parts i.e sensing or collecting data from environment according to application, processing the collected raw data and then send it to the cluster head. Where the cluster head aggregate the data, process it and send the result to the sink node. All the process describes above require certain amount of energy. Most of the energy is required by the data transmission task and least energy will be consumed when the sensor nodeis in the idle state or sensing. All the communication, processing and sensing should be performed by considering the limited amount of energy provided by the batteries. Some sensor nodes hesitate to have direct communication with a distant destination because high transmission power is required for attaining a reliable transmission. Low-energy adaptive clustering hierarchy (LEACH) [5] uses local data aggregation to reduce global communication so that some amount of energy can be saved. It also enhances network lifetime when compared to fixed Cluster Head schemes. There are number of cluster based, routing based protocols have been develop to minimize energy conservation. However, a large amount of energy is consumed by node components such as processor, transceiver, etc. even if they are idle. So there is some power management schemes are used for switching on & off the node componentsthat are not temporarily required. As the new technologies emerging it can be possible to harvest energy from the environment so that the power constraints of the sensor nodes can be reduce in some extent (Power scavengers). Main sources for acquiring or recharging the energy are:**[7][9]**

- Solar: It is a much known source of energy so some techniques can be adopted or developedbased on solar energy. (Generated by sunlight or artificial light)
- Mechanical: energy can be generated by the movements of objects.
- Thermal: Here energy can be generated by temperature differences between two objects.

III.1 Applications of Wireless Sensor Network

III.1.1 Process Management

Monitoring of a particular area is the main application of the wireless sensor network. WSN has been deployed over the region in which particular information has to be sense. For example in the geo-fencing of the gas station has been empanelled with the wireless sensor node for collection of any intrusion caused by the enemy.[11]

III.1.2 Health care monitoring

Wireless sensor network has been widely used in various application of the health monitoring that is related to two different types of devices. Wearable and implanted are the two different devices that have been used in the hospital monitoring system. Wearable devices are located on the surface of the body and the implanted devices have been implanted internal in the body so that information about the health related vitals can be collected. Wireless body area network is the best example of the utilization of wireless sensor network in health monitoring system.

III.1.3 Environmental/Earth sensing

In the environmental monitoring various applications of wireless sensor network has been utilized in routine life. Various types of temperature sensing devices have been deployed in various regions so that information about the environment can be collected and decision can be taken for survival.

III.1.4 Air pollution monitoring

WSN has been deployed for sensing of the pollution available in the air in various cities. In this process sensors have been deployed and quality of air index has been determined from this sensor. Wired communication based installation of sensors is a critical process that has been done by using the wireless sensors for mentioning pollution available in the air.

III.1.5 Forest fire detection

In the forest area wireless sensor network has been deployed for the utilization of information about the fire incident occurred. Various types of sensor nodes have been deployed over the forest region that estimates the information about the temperature, gages and humidity occurred in the forest. On the basis of this information estimation about the fire incident in the forest area can be estimated and the hazards can be stopped. [11]

III.1.6 Landslide detection

In the hilly area occurrence of landslide is the major concern that have to be detected early based on the geo graphical sensing information. In these areas sensors have been deployed that can be utilized for the detection of soil movement and various other parameters that are necessary for detection of the land sliding. This information has been collected by using the WSN and the alert to the region has been implemented.[12]

III.1.7 Water quality monitoring

Quality of the water has been estimated on the basis of various factors that have been collected from various water resources. In this process sensor has been deployed over various water resources like lakes, oceans and dams. The information collection center has been established in the nearby places because of the dense medium transmission of the information reduces as compare to the open air environmental data transmission. WSN provide vital role for detection of the water quality in the variousresources available.

III.1.8 Natural disaster prevention

Natural disasters can be detected using the wireless sensor network. Sensor nodes have been deployed atvarious rivers for estimated of water level at various intervals of time. On the basis of the information transmission by the nodes the estimation of the floods can be computed and the region can be alerted to avoid various hazards.

III.1.9 Machine health monitoring

Sensor plays an important role in the maintained of various machines for the maintenance and other functionality related services. Various types of sensors have been attached to the machines that provide information about the any leakage and any damage occurred over the part of the machine. Devices connected to the machine provide information about the health of the machine at each interval of time sothat maintenance of the machinery can be done. This process saves cost and time of the organization.

III.1.10 Data logging

WSN has been used for the data logging process so that collection of the data can be done and used in various applications so that automation of the application can be done on the basis of this information. Data collected from the sensor node can be taken as input for the machine learning model so that automation of various devices can be done to act wisely during unhealthy conditions.

IV. Machine Learning Techniques

ML techniques are generally applied for discovering knowledge-based information and extracting features or recognizing patterns from large quantity of data. At present, majority of the researches are focusing on machine learning. Use of ML in WSNs may be seen with many improvements on traditional methods. Here we discussed some ML techniques that have been utilized as a part of WSN.[16]

4.1.1 Supervised Learning: The goal of supervised learning is to predict the worth of associate outcome live supported variety of input measures. The result measure may be numerical orcategorical.Learningisperformedonacollectionoftrainingsamples.Iftheresultiscategorical,the learning referred as classification problem. For a classification problem, we'd like to determine
(a) what options to live and (b) what learning rule to use to maximize the training accuracy.

4.1.2 Semi-Supervised Learning: Semi-supervised learning, a category of supervised learning tasks and techniques that additionally build use of unlabeled data for training – usually a little quantity of labeled information with a large quantity of unlabeled information. Despite of employing only small volume of labeled data Semi-supervised learning has higher performance

4.1.3 Unsupervised Learning: Unsupervised learning accustomed draw inferences from datasets consisting of input data while not labeled responses. The foremost common unsupervised learning technique is cluster analysis that is employed for exploratory knowledge analysis to seek out hidden patterns or grouping in knowledge.

4.1.4 Reinforcement Learning: Reinforcement learning (RL) is one in all the intelligent algorithms. It deals with an environment in which an agent takes actions to achieve reward. Thewell known RL algorithm is Q-learning, assigns a Q-value to every agent which are frequently updated. Q-value of action at current state is defined as computation of total future reward.

4.1.5 Computational Intelligence Algorithms: Computational Intelligence (CI), the study of adjustive mechanisms that modifier facilitate intelligent behavior in complicated and dynamical environments. These mechanisms embody paradigms that exhibit a capability to be told or adaptto new things, to generalize, abstract, discover and associate. CI is outlined because the process representations and tools of intelligence able to be placing raw numerical sensory knowledge directly providing reliable and timely responses and withstanding high fault tolerance. CI involves paradigms like ANN, reinforcement learning, swarm intelligence, organic process algorithms. Certainly, there exist additional CI techniques, that don't seem to be mentioned as they need not been applied to WSNs is suesnonetheless.

V. Comparative Analysis of WSN Techniques

M/C Learning Technique	WSN Challenges					
	Routing	Clustering & Aggre.	Link Quality Esti.	Life timeExte.	EnergyManage.	QoS
Matric Map	Y	Y	Y	-	-	-
Naive Bayes	-	-	-	Y	-	
SVM	-	-	Y	Y	-	-
Multilayer Perceptron	-	-	-	Y	Y	-
Neural Networks	Y	Y	-		Y	Y
Semi Supervised Learning	-	Y	-	Y	-	
Hybrid Learning	-	Y	-	-	-	Y
Unsupervised Learning	-	Y	-	Y	Y	Y
Reinforcement Learning	Y	Y	-	Y	Y	Y

Game Theory	Y	Y	-	Y	Y	Y
Computational Intelligence	Y	Y	-	-	Y	-

Table 1 WSN Challenges with their solution Based on MachineLearning Techniques

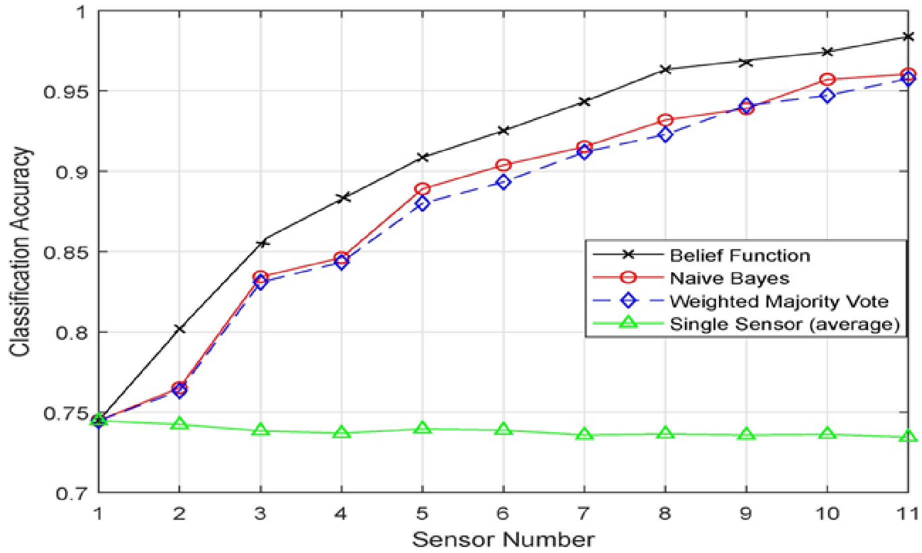

Fig.2. Machine Learning Algorithms and Fault Detection for Wireless Sensor Networks

VI. Challenges in Wireless Sensor Network

There are four basic directions in which current issues in WSNs can be broken down. These directions necessitate the attention of researchers. Despite the fact that those difficulties have been examined in various studies, there is still a need to address them in more depth.

VI.1 Security: The primary concern in WSNs is security. Secure data aggregation algorithms, secure routing protocols, and intrusion detection are three perspectives on this subject.

VI.2 Energy Efficiency: Sensors are intelligent devices that can perceive, deliver, and receive data. Allof these processes use energy. Sensors, on the other hand, lose the greatest energy during communication processes [23]. As a result, dealing with their energy with care is an important factor that must be taken into account. So, energy-efficient communication is essential to extend the lifespan ofsensors and, eventually, the network as a whole.

VI.3 Localization: In WSNs, localization is critical for determining the position of nodes. The use of GPS to locate node sites is not feasible because of its high cost. Non-GPS localization techniques are therefore required to fulfill this process [25].

VI.4 Real-Time Applications: In WSN, real-time requirements should be met by the most emergent applications. The fundamental needs of real-time applications are quality of service (QoS), and timely delivery.

VII. Advantages of Wireless Sensor Network

The following are some of the benefits and drawbacks of WSNs:

VII.1 Advantages of WSN

Following are the advantages of WSNs:

VII.1.1 WSN can predict natural disasters: Some applications for WSNs have focused on the early development of environmental changes and the sensing of the earth. Researchers have successfully deployed WSNs to identify the beginning of forest fires by adjusting temperature and humidity and to avoid earthquakes by detecting subtle soil changes that could cause a major earthquake.

VII.1.2 Installation: No drilling, cabling, or structural building modifications are required to mount wireless sensor systems. This ensures that the installation costs are reduced and infrastructures are minimized.

VII.1.3 Cost: WSNs are much cheaper than wired networks. This avoids plenty of wiring.

VII.1.4 WSNs are capable of securing hardware and data properties: Business organizations must incorporate temperature sensors into their data centres in order to avoid data loss and unpredictable downtime caused by hot servers. Servers are frequently housed in these data centres. The present wire passage will become even more congested with the addition of more cable sensors. The benefits of real- time temperature sensing in your data centres can be easily realized by using wireless sensor nodes instead of several additional cables in the area.

VII.1.5 Scalability: Scalability is a key consideration while developing an effective system. Any network must be adaptable to changes in its architecture. As system workload expands, the scalability must be accomplished well.

VII.1.6 WSNs in harsh and hostile conditions are successful: In the extreme and harsh conditions where wired networks cannot be implemented, WSNs are used. For example, wireless sensor nodes arepositioned in the forest because it is not feasible to go there and mount a wired system.

VII.1.7 WSNs allow the collection and transmission of long-distance data: Any WSN sensor node serves as an interface between other network sensor nodes and the principal place where data must eventually be transmitted. The majority of sensor nodes in many WSN applications are entirely outside the wireless communication range of their main location: they depend fully on signal relays and cooperation from other node in the network in which their data is transmitted [28].

VIII. Disadvantages of Wireless Sensor Network

Following are some of the limitations of WSN which need to be overcome [30].

- The relatively simple operation of sensor node devices enables the easy deployment of such networks, but it also makes them vulnerable to malicious security attacks. Therefore WSNs involve robust security systems.
- In comparison to wired networks, WSN networks are not stable. Network hackers can easily hack these kinds of systems. The WSNs can be widely spread across an area, which means that several sensor nodes may be used by a malicious attacker to access the network.
- Sensor nodes with minimal processing, storage and communication resources work under extreme energy constraints.
- Managers or operators have trouble for directly controlling the network. The network structure should also include a remote or an indirect method to manage the network.

They have limited energy, storage capacity, and processing bandwidth for communication

IX. Scope for Further Research

As per the results discussed in the conclusion, more research is required to enhance the effectiveness of energy efficiency. The following are the suggestions for the researchers to enhance the research work in future.

- To bring important increases to the proposed model, more research is required to assess the effectiveness of artificial intelligence and machine language on any other such clustering technique which can give more optimized results.
- Novel additional Intelligent protocol can be designed to introduce more efficient data communication and coordination between the sensor nodes.
- The multi objective optimization approach with more parameters or factors can be used to select optimal cluster head.
- The latest optimization techniques can also be implemented for improving the network lifetime.
- Detection and prevention system can be deployed to enhance the security level of the proposed scheme.

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