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SURVEY ARTICLE

A Survey on Clustering Algorithms and Proposed Architectural Framework for Border Surveillance System in Wireless Sensor Networks

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Abstract – Border Surveillance system is a major security issue in all nations. In border surveillance systems, wireless sensor networks are one of the most important technologies which are going to play a vital role in future research. Researchers address the variety of challenges and spread the deployment in large areas in real time. In this paper, an overview of the border surveillance system their applied technologies, and the challenges faced during the deployment are discussed. An architectural framework for the border surveillance system is developed and presented. A comprehensive review is conducted with different routing protocols based on the node's mobility, node's localization, routing metrics, delay, throughput, energy efficiency, and their network lifetime. Simulation results of various protocols are conducted and presented. This work is intended to identify and focus on recent protocol developments and also opens research issues that need to be investigated in the future.

Index Terms – Wireless Sensor Networks, Clustering, Routing, Raspberry Pi, IoT, Intruder Detection, Border Surveillance.

1. INTRODUCTION

Recent advances in sensors are generally equipped with data processing and communication capabilities. Wireless sensor networks are a large number of tiny nodes that combine and reconfigure themselves for a specific task. WSN is used in a wide range of applications, including nuclear-threat detection and their measure their radiation levels, cracks in building structures and ships, volcanic eruptions, biomedical applications, earthquake detection, aircraft buildings, and seismic monitoring. Mostly in the olden days, there are pre-created routes for border patrolling which involves a large number of humans which is a big problem in border areas. Major issues are the cost of the sensor is very high and integration of multiple sensor data and maintaining multi-layer protocols and their data makes it more difficult. Real-time monitoring with high accuracy in border areas with minimum support from humans is a tedious process. Data is transferred from the sensor nodes to the base station wirelessly in WSN. Sensors are used based on the application to measure parameters like temperature, humidity, light, and so on. The measured value reaches the base station by passing through all intermediate nodes.

Patrolling the border and preserving national security are the responsibilities of a border security unit. Rajiv Singh et.al., [1] Border patrol prevents unauthorized access and criminal activity. It is necessary to recognize the intruder's face and other relevant aspects to use an intelligent automatic border surveillance system. The sensor nodes are tiny in nature with limited energy capabilities, they can sense only some limited area and a large number of nodes deployed at high density.

There are huge difficulties in the chain of importance of identifying the applicable amounts, checking, gathering, and accumulating the information, assessing the data assembled and performing decision-making. Energy supply to sensor nodes is battery-based, as nodes are deployed in an unattended environment. There are characteristics like type of service, fault tolerance, lifetime, scalability, and maintainability. It is a great challenge to find mechanisms that are specific to any environment and support all characteristics. Bhadwal et al.,[2] suggested a Smart Border monitoring system that detects intruders using PIR sensors. Once identified, motors operated by a raspberry PI move the security camera in both the vertical and horizontal directions. If the raspberry controlled camera detects human presence, a warning is given and an alert is transmitted to the control, where military action may be started. Border surveillance is the most needed part in all the nations around the world.

Figure 1 shows that sensor nodes, camera nodes, base station, and mobile sink with UAV are deployed and data are

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collected. Here some real-time scenarios where smart border implementation is taking place in the world. The United Nations likewise addresses line security under the UN Counter-Terrorism Center (UNCCT) Border Security Initiative (BSI) plans to help the Member States in executing the United Nations Global Counter-Terrorism Strategy and intending to the general troubles in the space of coordinated boundary, cross-border collaboration, and border surveillance, including the avoidance of movement of the foreign terrorist fighters (FTFs). The Indian government launched a project of Smart Fencing at India Pakistan Borders and India-Bangladesh Borders in 2018 to make the borders more secure using the Laser Fencing technique. Sensors like underground sensors, vibration sensors, and radars were mounted on different platforms like towers and poles as part of a smart fence.

According to the government, techniques and solutions for border security will prove to be an effective way in assuring to reduce the casualties of our military personnel at the borders. Smart Fencing surveillance would make it virtually impossible for intruders to do security breaches and infiltrate the borders. In stage 1 they had achieved 71kms and aims to move on to Stage 2 and Stage 3 with total coverage of about 1955 Km and 2026 Km respectively which is vulnerable and where more security is needed for surveillance. The rest of the article is further organized as follows: Section 2 focuses on the related work on clustering, energy efficiency, data aggregation, and cutting-edge approaches. Section 3 talks about the analysis of distinct clustering protocols. Section 4 focuses on the proposed architectural framework for border surveillance. At last Section 5 concludes the article and discusses the prospects for the future.

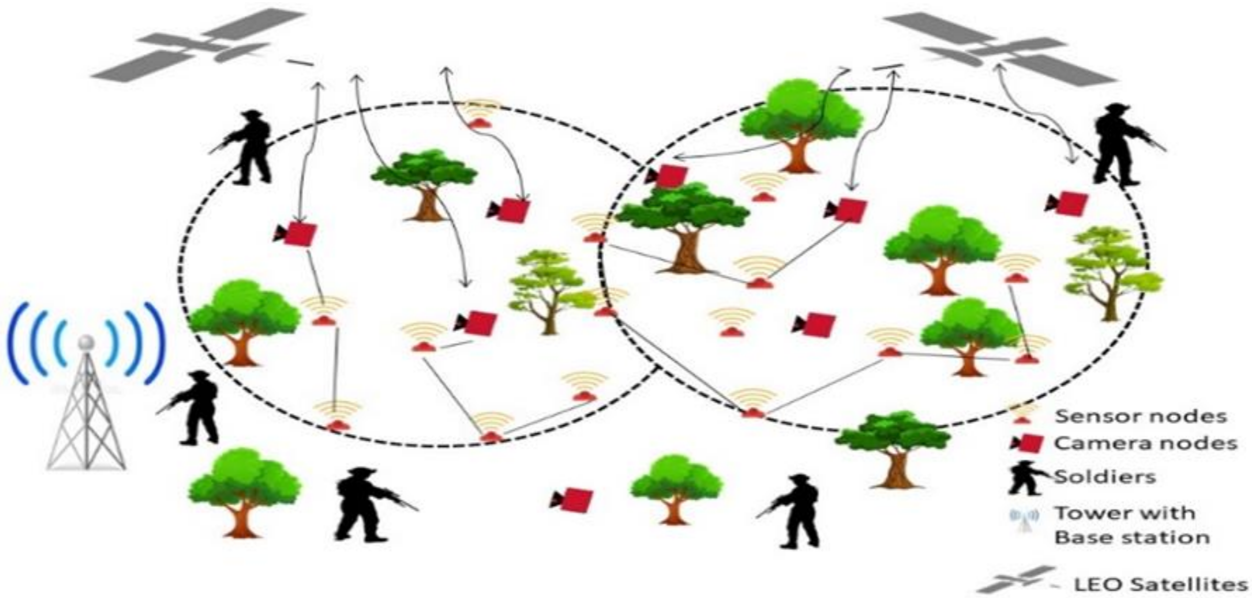

Figure 1 Border Surveillance System

2. RELATED WORK

The literature on several modules, including clustering, data aggregation, security, energy efficiency, and localization, is presented in this part. Each module describes how the wireless sensor network increase’s fault tolerance, energy efficiency, and network lifetime. Figure 2 shows the literature survey flow diagram.

2.1. Survey on Clustering

Dande et.al.,[3] proposed a Probabilistic Sensing Model (PSM). In this model, the author suggested a mechanism which seeks to enhance the surveillance quality for a specific surveillance area. While developing the algorithm Maximizing the Surveillance Quality of Area Coverage (MSQAC) two difficulties were looked upon. The primary problem is with an energy discharge rate and the contribution of each sensor is secondary. It performs well in terms of coverage ratio, surveillance quality, and fairness indexing. In MSQAC while taking heterogeneous WSNs which include various types of sensors into account The limitations of this investigation also be loosened because each sensor node sensing range is adjustable.

T. Chindrella Priyadarshini et.al.,[4] The author presented the Energy Efficient Evolutionary Algorithm-based Clustering with Route Selection (EEEA-CRS) algorithm, which improves network durability, packet loss ratio, and the average level of energy utilization. The recommended method doesn’t offer security while aggregating data, so a simple ciphering method is used for encrypting the data.

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Shagari et.al.,[5] the author proposed a Hybrid Equal and Unequal Clustering (HEUC) model to maximize the lifespan of WSNs. In this study, the proposed algorithm combined with zone-based clustering which addresses the inter-cluster idle listening and hotspot concerns. The outcome demonstrates that, when compared to Energy-Balanced and Unequally-Layered Routing Protocol (EBULRP) [6] and Adaptive Energy-aware Cluster-based Routing (AECR) [7], respectively, the suggested HEUC offers lifetime improvements of 38% and 51%. With dynamic cluster creation and random node placement, the multihop routing with an inter-cluster idle listening problem is yet to get addressed.

The optimal values of the variables in the compressive sensing paradigm are determined by multiple objective genetic algorithms (MOGA). MOGA [8] uses a fitness function vector to look for Pareto-optimal solutions based on Pareto-Optimality. A metaheuristic algorithm called the MOGA is often employed in WSNs to optimize a variety of conflicting objectives. By balancing these parameters, the energy efficiency will be maximized and the probability of a reconstruction issue would be decreased. Between these two objectives, MOGA provides a good middle ground. The base station employs the MOGA to compute the ideal number of measurements. The optimal transmission range, and the optimal sensing matrix. The above method offers a dynamic building of WSN based on the values of optimization variables and objectives at the beginning of each construction cycle.

Elsayed et.al.,[9] Proposed a Self-Adaptive Autonomous Fault Awareness Model (SAAFA) which is used here with cluster head node's which make local decisions and data sent to the base station directly In the SAAFA algorithm relationship between fault detection and the energy consumption is considered. In this model, each node doesn't need to communicate with neighbors whereas it can directly communicate with the head node and so the energy of each node got consumed. In this algorithm, a fault node is identified and got isolated from the topology. By using the optimization algorithm and removing the interference, this model increases the network performance to 98.63%, and the noise ratio in the signal decreased to 97.7%. Adaptive algorithms based on heterogeneous network and external disruptions is the major issue.

Farahani et.al., [10] proposed a homogenous Double Leveled Unequal Clustering protocol, (DLUC) where traffic is split among the cluster group members and reduces energy consumption. A local and remote cluster is used for the effective utilization of bandwidth and time. The gateway node in this model is a separate node which reduces the burden of the cluster head and the relay node. The DLUC model is compared with the Hierarchical Energy-Balancing Multipath routing (HEBM) model while DLUC outperforms well in terms of increased throughput and decrease in energy consumption due to less reclustering of nodes. A heterogeneous double-leveled unequal clustering protocol and mobility of the nodes is the issue with this method.

Thi- Kien Dao et.al.,[11] proposed An Improved Multiverse Optimizer (IMVO) and improved Forward Neural Network (FNN) which increases the degree of accuracy and processing speed, whereas it is also used to identify the cluster head failure data. The major issue with this model is it only accepts homogeneous models and when it got implemented over a large-scale network the lifetime of the network get decreased. Thi-Kien Dao et.al., [12] Proposed an information collection and group head selection algorithm which optimizes the data loss and fault awareness determination done by a Support Vector Machine (SVM) and Improved Flower Pollination Algorithm (IFPA). The IFPA algorithm is compared with other algorithms like Flower Pollination Algorithm (FPA-SVM), Particle Swarm Optimization (PSO-SVM), Genetic Algorithm (GA-SVM), SVM Default, and the IFPA algorithm performs well in terms of parameters like False Polynomial Rate (FPR), Polynomial, Spline with c parameter 411,131,2,29 respectively. There is a 55% growth when compared to SVM, 65% with Hidden Markov Model (HTT) and 69% with Decision Tree (DT). Thus, the proposed methodology shows the most suitable way for forwarding the collected data, by providing a throughput of 97%.

Augustine et.al.,[13] the author had proposed a methodology for cluster head selection which is based on the lifetime of the network using a Taylor kernel fuzzy C-means (TKFCM) with criteria like hop distance for transmitting the data and energy of the nodes in the cluster. Xinyi Liu et.al., [14] In this methodology uses a clustering algorithm based on differential evaluation with three stages and an optimization algorithm with simulated annealing (SA) with chaos optimization algorithm (COA) for path planning model and increased the system energy utilization. In the clustering algorithm, a non-uniform clustering with a differential evaluation when 10% of the nodes act as a cluster head, and the rest of the node's act as member nodes. An assistant cluster head is assigned for each cluster head which is responsible for the optimization. Cluster head rotation is done with the help of the assistant cluster head when the energy of the cluster head is low.

Diwakaran et.al., [15] proposed an Autoregressive Integrated Moving Average (ARIMA) modeling which is used with Principal Component Analysis (PCA) for reducing the data compression ratio and the throughput is achieved around 82%. Throughout all, 3500 iterations were completed in the proposed model's lifespan of the network till 2500 rounds half the nodes are still alive and have completed 3000 rounds. In contrast the lifetime of the network to the spatial method's 2100 rounds and the temporal-based method's 1800 rounds.

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There are two models present supervised and unsupervised models and they used only the unsupervised model. Using a Linear *Discriminant Analysis* (LDA) supervised model and relatively check with their comparison.

J. Ding et.al., [16] Proposed a methodology of Noise-Based Density Peaks Clustering (NB-DPC) scheme to detect the attacks in the cluster networks and increase the detection of abnormal behavior. By using the Cumulative Forwarding Rates (CFR) it detects malicious attacks done through selective forwarding. The NB-DPC algorithm is the improvised version of DPC by cutting the unnecessary steps carried out. The results show that Missed Detection Rate (MDR) and False Detection Rate (FDR) are less than 1% in the proposed methodology. The NB-DPC is compared with the Date Clustering Algorithm (DCA), k-means, Dynamic Parameter- Density-Based Spatial Clustering of Applications with Noise (DP-DBSCAN), and IN-Monitoring. The results of FDR show that NB-DPC is 0.7%. They compared with the watchdog mechanism, IN-Monitoring mechanism in terms of MDR and FDR here NB-DPC has 0.375% and 0.56% respectively whereas other mechanisms got higher rate. If the total forwarding packets of the NB-DPC are changed and checked the abnormal node or malicious node, the CFRs algorithm checks the results for isolation of the malicious node.

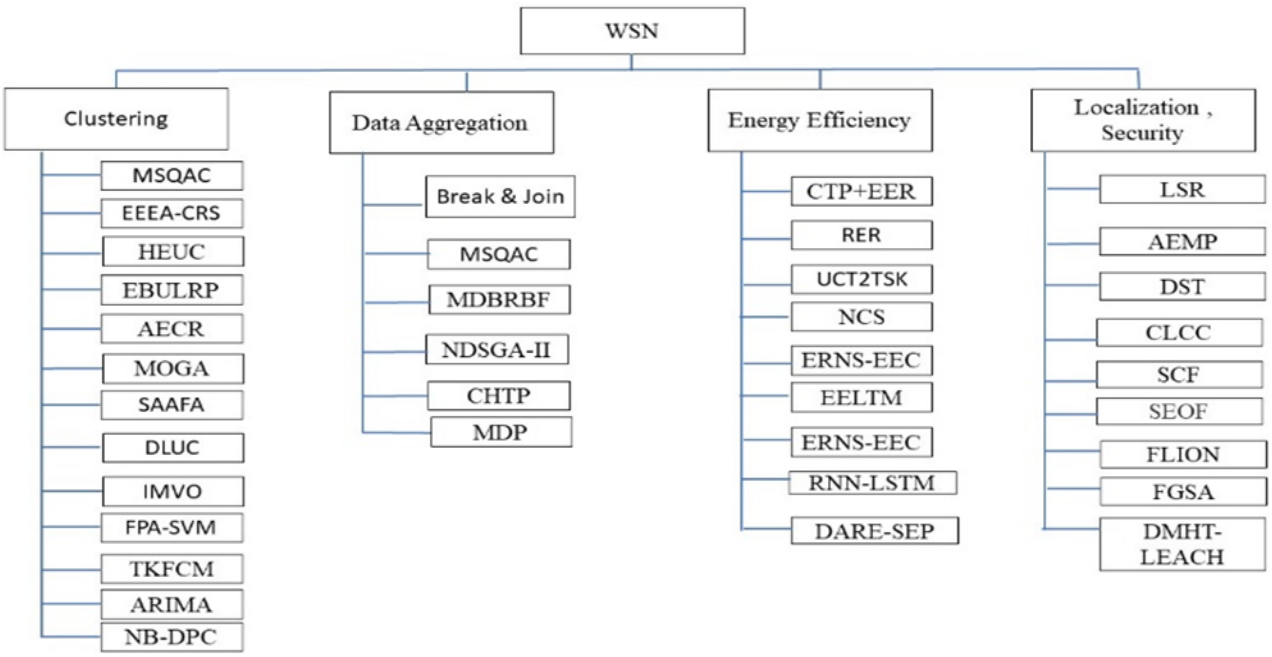

Figure 2 Literature Survey Flow Diagram

2.2. Survey on Data Aggregation

Tien-Dung Nguyen et.al., [17] proposed a tree grown with the head sink node, and the priority of the nodes transmission time without collision is discussed. With the help of the Break and Join (B&J) algorithm, the primary collision problem is solved and the secondary data collision is the major issue in this method to update the parent nodes, the Break-and-Join procedure, which calculates metric Minimum Aggregation Time (MAT), is utilized. It has been evaluated that 13% of the aggregation time, when compared to the existing schemes. Jung Woo. Kim et.al., [18] proposed a Real-Time Motion IoT Detection (RTMID) platform that is applied with a Non-Contact Sensor Module (NCS) with Raspberry pi. A non-contact hardware module and a Motion Recognition Visualization Printed Circuit Board Module (MRV PCB) based on open-source hardware are both included in the RTMID platform. The user logs into the system and accesses the stored information using an application. The NCS module broadcasts the specified information to the smartphone, which is around 80 meters away. The NCS module actively monitors data faults as real-time data is transmitted. The response rate of the real-time data supplied via the application may be used to determine whether the data was successful. The least necessary time, maximum required time, and average required time for gathering and viewing 10 data is 2.03, 2.27, and 2.158 respectively. The Motion Detection Monitoring Algorithm (MDMA) is recognizing the object and the data packets are transferred with no delay. If there is a weak network signal there is a packet loss and delay which should be taken into account.

Insan Ullah et.al., [19] proposed a Mahalanobis Distance-Based Radial Bases Function Extreme Learning Machine (MELM) using a kalmn filter (KF) extended to the Mahalanobis Distance-Based Radial Bases Function

(MDBRBF) introduces the novel data aggregation scheme based on a node cluster. It effectively minimizes the loss and increases the accuracy of clustering. The MELM model decreases the amount of data, uses less energy, and extends the lifetime of the network while increasing clustering efficiency. The clustering of the sensor node's, the KF phase, and data processing make up the three primary phases of the MELM method. The noise and bias in the original data are being reduced by the KF. The MELM method is contrasted with LEACH, polynomial regression-based secure data aggregation (PRDA), and perceptron neural network-based data aggregation (PNNDA). Compared to the current protocols there are 45% of alive nodes in 50 rounds.

Ming-Tao et.al., [20] Proposed a model which implemented the full coverage subgraph by using the K-center problem, and a Non-Dominated Sorting Genetic Algorithm-II (NDSGA-II) is implemented and efficiency with authentication delay is calculated. Due to the added messages in the sessions, the communication cost had been increased much in other protocols whereas in the real-time proposed protocol the communication cost between the Control Center (CC) and Unmanned Ariel Vehicle (UAV) is around 96ms and the communication cost between the UAV and the end sensor is around 8.9ms which is due to the local deployment of the UAV.

Farah Kandah et.al., [21] The author proposed methodology a trust-based cluster mechanism and presented a Cluster Head Trust Propagation (CHTP) algorithm implemented with Direct trust and Indirect trust for secure communication and energy is concerned. By adopting this CHTP approach, the network's lifespan is extended, network holes are delayed from forming hostile nodes are neutralized, and battery consumption is reduced as compared to proximity and random clustering strategies. When comparing the CHTP strategy to trusted pollution managers, it can be shown that 45% of trust managers are required when 20% of the nodes are malicious, and only 25% are required while using CHTP.

Prabu et.al., [22] Proposed a methodology in which multiple Mobile Data Patrons (MDP) were implemented for the data collection, where the mobile patron energy gets depleted and it has been communicated to the base station directly. The whole area is segmented into several regions, and each region is assigned a mobile patron, so data collection becomes quicker as a mobile patron has a greater transmission range, and to handle the energy depletion issue, MDP employs a specific pattern, so there is no data loss by using this approach, the shortest distance for data collection and speed of data collection are addressed.

2.3. Survey on Energy Efficiency

Navarro et.al., [23] To obtain a higher network lifespan in WSNs, the authors developed a combination of Collection Tree Protocol + Energy Efficient Routing (CTP+EER) protocol. In this model, a cost-based routing protocol and a random component are introduced to a process the of packet and packet forwarding. The packet reception rate, transmission cost, and duty cycle were all considered in the evaluations. This model's energy consumption in the routing layer transmission cost ranges from 11% to 59%, and it maintains roughly 99% dependability with a duty cycle of 7% to 35%. When compared to typical cost-based routing protocols, CTP+EER outperforms. The proposed CTP+EER algorithm can be further enhanced by discovering new methods for member selection of a parent cluster.

Rudramurthy et.al., [24] The author proposed a Reliable and Efficient Routing (RER) model, which reduces energy consumption, delay, and packet loss. The RER paradigm lowers communication latency, increases the lifespan of WSNs, and minimizes energy usage. The RER model reduces communication costs by lowering reclustering overhead through the selection of an Assistant Cluster Head in the RER model, as well as lifetime due to the adoption of improved CH and Assistant Cluster Head selection in an uneven clustering environment. Comparing the RER model to the LEACH and Unequal Clustering methodologies using Type-2 TSK fuzzy logic theory, (UCT2TSK) [25] routing models as a baseline, a considerable improvement is made. The packet delivery ratio is increased by 20.31% using RER and gains in performance over time of 83.56%. Increase in packet delivery ratio of 20.31%. Packet loss is experienced, less than 53.82 percent.

J. Udhya Kumar et.al., [26] proposed a A Neighborhood Correlation Sequence (NCS) approach, which reduces energy usage and to compress the image after it has been encoded by a codec and increases the compression ratio of the node by using LZMA (Lempel Zuvmarkev Algorithm) compression and decompression is made, and overall transmission overhead is eliminated. Minimum E2D is 107.46 ms with a bit rate of 4.40bpp and SNR is around 48.06 with an average SS of 45.03%. In the encoding schemes, other techniques need to implemented and performance compression to be evaluated.

Anurag Shukla et.al., [27] proposed Effective Relay Node Selection and energy-efficient Communication (ERNS-EEC) protocols that were also implemented for the cluster head node selection and easy communication with low cost. Compared with older protocols like Minimum Energy Consumption Chain-Based Cluster Coordinator Algorithm (ME-CBCCP), Energy Efficient Sleep Awake Aware (EESAA), and Threshold Distributed Energy Efficient Clustering (TDEEC) the proposed model works well in terms of energy consumption and increases the scalability of the network by effectively selecting the relay node. Here Friis model is considered for energy depletion. When compared to ME-CBCCP the proposed protocol ERNS-EEC the number of (Relay Nodes) RN's reduced from 55% to 45 % respectively.

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K.S. Arikumar et.al., [28] Proposed an Energy-Effective Lifetime Maximization (EELTM) approach that was used to determine the cluster head, cluster route using a Particle Swarm Optimization (PSO), and fuzzy-based node selection which balances the cluster formation. In this model parameters were selected like First Node Expire (FNE), Total Remaining Energy (TRE) were selected, when considering the FNE parameter to other protocols like Energy Aware Unequal Clustering with Fuzzy (EAUCF) and Energy Efficient Unequal Clustering (EEUC), the proposed EELTM performs well by obtaining 30% better than compared algorithms. EELTM methodology overwhelms the other protocols by 14%. Using the FNE parameter, EELTM outperforms EAUCF and EEUC by 18% and 23%, respectively. When compared to other protocols, this technique consumes less energy and achieves network stability. Mahdi Khalili et.al., [29] proposed a multi-objective genetic algorithm for energy consumption and end-to-end delay, the algorithm is based on Me-NSGA-II in the direct and co-operative approach and the energy consumption is reduced to 65%.

Sachi Nandhan Mohanty et.al., [30] proposed a methodology overhead for the energy, and the utilization is reduced which increases the throughput by using the Recurrent Neural Network and Long-Term Memory (RNN-LSTM) with distributed data mining method. In the RNN-LSTM model the average delay is around 190ms when compared to other models like Open Shortest Path First (OSPF), and Deep Neural Network (DNN) the average delay is around 230ms respectively. The maximum signaling overhead of OSPF and DNN are 120 ms and 34ms respectively on the other hand, the proposed methodology is 28ms. The RNN-LSTM model throughput is high when compared to DNN and OSPF.

N. Gharaei et.al., [31] The author employs the power bank as the broker between sensor nodes and wireless mobile chargers (WMC). Transfer of recharging duty from the WMC to the power bank reduces the overhead. The coupling method is used for identifying the needed node to recharge and that particular node will be provided with the mobile charger. The queue will be eliminated for the charging cycle. To recharge the nodes, a timestamp-based energy division approach is used. In the Broker based Node Recharging Scheme (BNRS) methodology, the computation time is very low and the energy level of the proposed methodology is high when compared to other methodologies like UCMC, NJNP, and FEEDS. If the power bank is made as a cluster head to determine the optimal value and to check the network efficiency.

N. Gharaei et.al., [32] proposed a methodology namely Route Optimization Wireless Mobile Charger (ROWMC) and Charge Time Optimization Wireless Mobile Charger (CTOWMC). In the ROWMC it is used to optimize the moving trajectory path with variance in lifetime left by the nodes and in CTOWMC methodology the charging time of WMC and to increase the network lifetime. Results show that when comparing to Han’s algorithm and Wang’s algorithm the proposed algorithm shows a better result in terms of network lifetime with more than 20000s in less density network and for high-density network, it is around 19000s. The transferred energy level of CTOWMC is very less around 0.8J for low density and for high density it is 1.5J compared to Hang’s and Wang’s and the computation time of ROWMC and CTOWMC is very less compared to the other two algorithms. The cooperation between the WMC and the moving sink nodes decreased the energy of the node and the lifetime of the network is the major issue with the packet loss.

A. Naeem et.al., [33] proposed a hybrid mode of “Distance-Aware Residual Energy Efficient Stable Election Protocol” (DARE-SEP) for providing the optimal route transmission from the sensor node to the cluster head. To reduce energy consumption, they use multihop routing. In the SEP protocol, the first dead node is on 806 and the last dead node is on 2170. In LEACH it is 563 and 2301 respectively. In the proposed methodology the node dead is 870 and 6683 respectively and there is an increase of network lifetime by 10 % when compared to other protocols. Node deployment in the WSN through this method is to be addressed, and network lifetime and energy consumption are to be checked.

2.4. Survey on Localization

Tisan Das et.al., [34] Proposed a model that is built along with a hexagonal model, in the previous models, the localization error is less whereas the path traversal is more. As a result, they suggested a linear hexagonal path traversal strategy for wireless sensor network localization. Inversed coverability and multiple beacon sites are taken into account. The simulation environment consists of an obstacle-less and obstacle-present scenario. In the obstacle-less scenario, the number of beacon points were identified as 1560, and, in the obstacle, the present scenario the number of beacon points was identified as 1537. A novel geometric-based path panning algorithm is implemented. In path traversal, a basic collision avoidance method is used and a Euclidian distance is calculated. Here the confinement blunder is limited yet the throughput, bundle misfortune, and energy consumption are high and it may be carried out for the dispersed network.

Ali Hydari et.al., [35] to overcome the source localization problem, the author proposed a Received Signal Strength Difference (RSSD) model with a “Fisher Information Matrix” (FIM) and with “Sensor Source Geometry” (SSG), equal and different sensor ranges were considered and the performance is increased. The performance of localization is improved by positioning the sensor closer to the source. Optimal sensor placement was divided into two types: determinant optimality and the inverse trace of FIM, which is

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A- optimality. When compared to other places, D-optimality and A-optimality performed well. The same approach should be used to create heterogeneous models with an optimal trajectory for shifting RSSD sensor locations.

Raj Vikram et.al., [36] proposed an Energy Efficient data forwarding forest fire detection using localization (EEFFL) scheme based on forest area which is split into grids and they are named active, medium active, and low active where each grid consists of eight neighbor grids, support vector machine (SVM) range-free localization algorithm, and greedy forwarding algorithm is used for transferring data between grids and interior nodes. The same method is implemented in the heterogeneous model and the life of highly active gid is reduced, it is a great concern and the low activation energy is not used effectively.

B. Ban et.al., [37] outlined the method rather than detour the failing path, they employ a homotopy as a novel topological notion for the design and assessment of various paths accessible in the network. To compute the various homotopy types, the author suggested a tessellation-free and GPS-free technique. The suggested approach is scalable and distributed. When compared to other current routing techniques such as Random Walker and SINUS, this approach has an extremely low stretch factor. The delivery rate under the independent node failure model for the surface networks need to be checked with resilient routing protocols.

Dhumane et.al., [38] The Fractional Gravitational Search Algorithm (FGSA) algorithm combines the gravitational search algorithm and fractional theory. In the IoT network, FGSA is used to iteratively determine the best cluster head node. The GSA (gravitational search) approach is used to estimate each node's position. GSA is used to understand fractional theory in order to update node location and identify cluster heads. MOFGSA method's major objective is to prolong the lifespan. Alnawafa et.al., [39] proposed an Enhanced Multi-Hop Technique EDMHT-LEACH is a dynamic data transmission method that connects cluster heads to base stations. To achieve this job, the EDMHT-LEACH protocol recommends four steps. The stages are as follows: initial, announcement, selection, and routing. To update the RT, EDMHT-LEACH the updated messages are received often from other CHs. As a result, the routing table's order may vary, and new routes may be chosen during the same cycle. The suggested technique in this study provides a cost value to each energy ratio. As a result, CH and IN with a power ratio greater than 50% are given low-cost values, while others are given high-cost values.

2.5. Survey on Security

Pathak et.al., [40] The author proposed a novel Lightweight Secure Routing (LSR) technique for managing sensor networks. In order to reduce the multi-objective optimization problem, this approach implements “Ant Colony Optimization” (ACO). In this model, adaptive security based on trust calculations, a QoS model, and two-dimensional Gaussian and uniform distributions were deployed. In the hybrid deployment strategy, 40% of the nodes were distributed uniformly, providing good coverage around the edges, while 60% of the nodes were distributed using two-dimensional Gaussian distribution to minimize the energy hole problem for larger density networks. A breach in data security might occur if any sensor node is hacked since the event data kept there could be obtained by an attacker. To improve data security, a blockchain-based trust architecture will be used. Because a blockchain is an immutable record, storing event data on it would improve data security.

Renukadevi R et.al., [41] proposed a new method using next hop, the routing path is chosen by using initial energy, remaining energy, and reliability of the network. To solve this problem, the “Addition Encouragement Multiplication Punishment” (AEMP) model is used. A reduced energy-consuming WSN model is created for further optimization using “Mixed Integer Linear Programming” (MILP). The throughput, residual energy, and network lifetime have all been enhanced by 30%, 13%, and 15%, respectively. Instead of focusing just on trust value, energy value, and dependability, other parameters such as packet transit time, distance, and hop count, the optimum path were taken into consideration.

Mohammed Aseeri et.al.,[42] described an implementation of Dampster Shafer Theory (DST), the vulnerability span ordinarily addresses likelihood and is supplanted by the limits of conviction and credibility. In the proposed methodology two methods DST and TDoA were combined to detect the location of the malicious node. TDoA technology is used in locating and positioning nodes, using this methodology, there is a reduction in latency and computation. Here for getting the higher exactness other algorithm calculations are to be incorporated.

Shaocheng Qu et.al., [43] Proposed a cross-layer congestion control (CLCC) mathematical model between the transmission layer and MAC layer and applied with fuzzy sliding mode control (FMSC) which regulates the queue length and reduces the disturbance in the congested node. By using the FSMC model there is an increase in speed and stability in terms of convergence delay, packet loss, and throughput. Here the network Cross-layer congestion with fuzzy logic will be optimized for better performance.

Neha Bhadwal et.al., [2] proposed a method for an intruder detection system (IDS) in which a video camera is mounted on a Raspberry pi microcontroller, and an infrared sensor is mounted and activates the camera. Pyroelectric infrared sensors are used. Here the data gathering method should be

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considered and thermal or vibrator sensors are used to obtain the distance of the object.

Chilveri et.al., [44] proposed a security protocol developed with elliptic curve cryptography (ECC) and providing a hash function in a protective manner of key exchange. A normal server and the master server are implemented and calculated for cost, security, and increased efficiency in communication. The correlation between the known plain text and plain text is -0.10694 which is very effective, then ciphering key between the plain text and decrypted key is very low, so the attack on this model is minimal. Thus, the proposed methodology has high communication efficiency when compared to other models. Using a centralized server creates an issue in terms of security. So, an enhanced protocol needs to be developed. Alberto Gallegas Ramonet et.al., [45] proposed a Sensor Coverage First (SCF) which is designed for multihop wireless sensor networks. It uses the highest replacement priority and changes the node. S. Verma et.al., [46] Proposed a “Sleep Scheduling Based Energy Optimized Framework (SEOF)” that works with energy-efficient cluster head selection, and sleep scheduling methodology is addressed for closely located sensors based on the threshold. Compared to other protocols like Energy-efficient Trusted Moth Flame Optimization and Genetic Algorithm (eeTMFO) [47], d Fuzzy Logic-based Effective Clustering (FLEC) [48], and Cluster-based Intelligent Routing Protocol (CIRP) [49] the results suggest that the network's stability period is 35.3% in the instance I and 216% in instance II and the throughput is 105519 packets and 1000667 packets respectively. If the sink node is in mobility and the placement of the sink node through this methodology is to be addressed and optimized for better performance.

Sirdeshpande et.al., [50] Fractional lion (FLION) clustering algorithm is an optimization-based method suggested for building energy-efficient routing paths and extending the life span and energy of the network by choosing the fast cluster head. The lion method is used to discover the fast-clustering head with better energy efficiency based on the fractional calculus model. The fitness function is utilized to find the rapid cluster centroid for an efficient routing path. Based on node energy, latency, and intra- and inter-cluster distance, the best cluster head is selected and optimized. Table 1 depicts the summary of literature survey.

Table 1 Summary of Literature Survey

Proposed Protocol	**Methodologies**	**Advantages**	**Inferences**
MSQAC [3]	MSQAC algorithm is developed based on the PSM model which enhances the surveillance quality for a specific surveillance area.	In terms of monitoring quality (QoM), coverage ratio, and fairness index, MSQAC performs well.	It is significant to focus on developing the MSQAC while taking heterogeneous WSNs which include various types of sensors into account. Additionally, since the sensing range of each sensor is changeable and loosens the restrictions of this investigation.
EEEA-CRS [4]	EEEA-CRS algorithm uses the combination of Fuzzy Chicken Swarm Optimization based Clustering (FCSO-C) and Optimization-based Multihop Routing phase (BBO-MHR). FCSO-C is used for identifying the cluster head and BBO-MHR is used for identifying the optimum path.	EEEA-CRS algorithm, which improves network durability, packet arrival ratio, and the average level of energy utilized.	The recommended method doesn’t offer security while aggregating data so a simple ciphering model can be used.

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HEUC [5]	A hybrid equal and unequal clustering (HEUC) model is implemented based on zone-based clustering which addresses inter-cluster idle listening and hotspot concerns.	The outcome demonstrates that, when compared to EBULRP and AECR, HEUC offers lifetime improvements of 38% and 51% respectively.	With dynamic cluster creation and random node placement, the inter-cluster idle listening problem in multi-hop routing is yet to get addressed.
MOGA [8]	The proposed methodology uses a fitness function vector to look for Pareto-optimal solutions based on Pareto-Optimality. A metaheuristic algorithm is often employed in WSNs to optimize a variety of conflicting objectives.	There is an increase in accuracy and energy efficiency with lower coherency to improve the Compressive Sensing (CS).	MOGA depends only on selective parameters like population size and iterations.
SAAFA [9]	In the SAAFA model used for a cluster head node make local decisions and data is sent to the base station directly.	By using the optimization algorithm and removing interference this model increases the network performance.	An adaptive algorithm based on heterogeneous networks and external disruptions is the major issue.
DLUC [10]	DLUC is proposed for optimally creating unequal cluster sizes and reducing the number of cluster heads by managing the common spaces between the clusters.	Homogenous double-leveled unequal clustering protocol, used for decreasing the energy overhead and traffic load is shared among the group of nodes and efficiently utilizes the transmission range.	Heterogeneous Double leveled Unequal clustering Protocol and mobility of the nodes are the issue with this method.
IMVO [11]	Proposed an improved multiverse optimizer (IMVO) and improved forward neural network (FNN) to reduce the local optimal problem.	IMVO increases the degree of accuracy and processing speed, whereas it is also used to identify the cluster head failure data.	Large-scale implementation & with heterogeneous mobile networks.
IFPA [12]	Proposed an information collection and group head selection algorithm.	IFPA optimizes the data loss and fault awareness determination done by a support vector machine (SVM)	Other parameters like energy efficiency need to be included & testing can be done for the efficiency of fault node identification.
TKFCM [13]	The cluster head selection is based on the lifetime of the network using a Taylor kernel fuzzy C-means with criteria like hop distance for data transmission and energy of the nodes in the cluster.	TKFCM performs well in terms of routing overhead, delay, throughput, and network lifetime.	The cluster head selection will be done on any other standard optimization algorithm and the performance can be analyzed.

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Double chaotic Optimal DE [14]	In this methodology, they use a clustering algorithm based on differential evaluation with three stages and an optimization algorithm with simulated annealing (SA) with chaos optimization algorithm (COA) for the path planning model.	Improvisation of clustering and increased system energy utilization.	The topological structure is fixed in this model, by varying the structure and also considering the other parameters like throughput, delay, jitter, and the performance can be measured.
ARIMA model [15]	ARIMA modeling is used to predict the data and PCA model is used for the data compression. If there is any variation in data that is present above the threshold then the data difference is communicated to the cluster head.	Data redundancy is reduced by 82% with the predefined error threshold and also reduced the collision between the data.	Here they are using the PCA (unsupervised) mode. LDA (supervised) model can be used and relatively the results can be compared.
NB-DPC [16]	They proposed a methodology of NB-DPC scheme to detect the attacks in the cluster networks. It omits the cluster core and halo which is used to identify the noise points.	It improves the identification of malicious node activity and the capability of recognizing noise points. The results show that MDR and FDR are less than 1% in the proposed methodology.	If the total forwarding packets rate of the NB-DPC is changed and checks the abnormal node or malicious node and the CFRs algorithm checks the results for isolation of the malicious node in the fog layer.
B&J Algorithm [17]	A tree is grown with the head sink node and the priority of the nodes transmission time without collision is discussed with the help of the break & join algorithm and the primary collision problem is solved.	The proposed B&J algorithm reduces the delay significantly and finds the lowest shortest path also the aggregated time is about 13% better.	Secondary collision is the major issue and the data aggregation rate for a secondary collision to be calculated.
RTMID [18]	Proposed a real-time IoT motion detection] (RTMID) platform is applied with a non-contact sensor module (NCS) with Raspberry pi. The motion detection monitoring algorithm (MDMA) is recognizing the object and the data packets are transferred with no delay.	NCS module transmits the signal when the communication device approaches 80m. The load of the network is well balanced when the communication devices are fewer.	If there is a weak network signal there is a packet loss and delay which should be taken into account.
MELM [19]	Proposed MELM using Kalman filter extended to Mahalanobis distance-based radial bases function (MDBRBF) which introduces the novel data aggregation scheme based on a node cluster.	It effectively minimizes the loss and increases the accuracy of clustering.	The proposed approach can be implemented with more sophisticated Q-learning methods.

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NDSGA-II [20]	Proposed a model which implemented the full coverage subgraph by using a K-center problem and a non-dominated sorting genetic algorithm-II (NDSGA-II) is implemented.	In the proposed model efficiency is increased with a nominal authentication delay.	Heterogeneous-based multiple mobile sink nodes can be implemented.
CHTP [21]	In the proposed methodology a trust-based cluster mechanism and presented a cluster head trust propagation algorithm are implemented with Direct trust and Indirect trust for secure communication and energy is concerned.	Flexibility and data integrity is achieved and also increase energy efficiency by reducing the overhead with the trust between the dynamic cluster head.	Throughput and delay are not calculated with the head node selection.
MDP [22]	In the proposed methodology multiple mobile patrons were implemented for the data collection, where the mobile patron energy gets depleted and it has been communicated to the base station directly.	There is no data loss, by this method, the shortest distance for data collection and the speed of data collection are addressed.	Quality of the data gathered nodes to be optimized.
CTP+EER [23]	A cost-based routing method increases the network lifetime in WSNs by adding a random component to the process of packing and packet forwarding, which is a cost-based routing algorithm.	This method drastically lowers the energy usage of the routing layer by 11% to 59% while maintaining 99% overall dependability.	The suggested EER algorithm may further be enhanced by discovering new methods for member selection of a parent cluster.
RER model [24]	The RER model reduces the reclustering overhead through the selection of an Assistant Cluster Head, adoption of improved CH, and Assistant Cluster Head selection in an uneven clustering environment.	In this study, the RER model, reduces energy usage, latency, and packet loss. The RER model shortens communication lag, decreases energy usage, and extends the lifetime of WSNs. The packet delivery ratio is increased by 20.31%	While moving for unequal clustering intra and inter-cluster problems are to be considered.
NCS algorithm [26]	The proposed NCS algorithm lowers the energy utilization and increases the compression ratio of the node by using LZMA (Lempel Zuvmarkev Algorithm) compression and decompression.	Bandwidth utilization, end to end delay is reduced and also transmission overhead is eliminated.	In the encoding schemes, other techniques were implemented and performance compression needs to be analyzed.
ERNS-EEC [27]	In ERNS-EEC protocol the cluster head node selection for easy communication is carried out at a low cost. friis model is used for the reduction of energy depletion.	Increased network lifetime, decreases the network cost, and reduces the energy usage .	Same technique to be applied with security, reliability, and heterogeneity with mobile networks to be considered.

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EELTM [28]	Proposed an energy-effective lifetime maximization approach that uses the FIS method to determine the cluster head and used a pso and fuzzy-based node selection which balances the cluster formation.	The cluster head is frequently modified in this model which increases the life span of the network.	FIS is only meant for energy and other parameters like quality, throughput was included with the mobile sink.
Me-NSGA-II [29]	The multi-objective genetic algorithm is proposed for overhead and delay consumption, the algorithm is based on Me-NSGA-II in the direct and cooperative approach.	It balances the per-hop energy consumption with end-to-end delay and reduced it to 65%.	It can be extended for the distributed network with the cooperative algorithm.
RNN-LSTM [30]	In the proposed methodology overhead for the energy, utilization is reduced which increases the throughput with distributed data mining method.	Data transmission is reduced and the distributed method reduces the overload in a fusion center.	Hyperparameters tuning techniques were applied and the outcomes should be considered with the RNN-LSTM algorithm.
BNRS [31]	Proposed a BNRS methodology that employs the power bank as the broker between sensor nodes and wireless mobile chargers.	Transfer of recharging duty from the WMC to the power bank which reduces the overhead. The queue will be eliminated for the charging cycle.	If the power bank is made as a cluster head and determining the optimal value and calculating the network efficiency are needed.
ROWMC & CTOWMC [32]	They proposed a methodology ROWMC is used to optimize the moving trajectory path with variance in lifetime left by the nodes and in CTOWMC methodology the charging time of WMC.	The proposed methodology focuses on increasing the network lifetime.	The cooperation between the WMC and the moving sink nodes decreased the energy of the node and the lifetime of the network is the major issue with the packet loss.
DARE-SEP [33]	They proposed a hybrid mode of DARE-SEP for providing the optimal route transmission from the sensor node to the cluster head. To reduce energy consumption, they used multi-hop routing.	There is an increase in network lifetime by 10 % when compared to other protocols.	Node deployment in the wsn through this method is to be addressed, and network lifetime and energy consumption are to be analyzed.
Linear-Hexagonal path traversal & Inversed coverability [34]	Proposed model of linear hexagonal path traversal scheme implemented for localization in wireless sensor networks. Inversed coverability and the number of beacon points are considered. In path traversal, a basic collision avoidance method is used and a Euclidian distance is calculated.	The number of beacon points and average localization error is reduced in both the absence and presence of obstacles.	Energy depletion is high and the same algorithm can be implemented for the distributed network to check their feasibility.

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RSSD with FIM [35]	Proposed an RSSD model with Fisher Information Matrix (FIM)and with Sensor Source Geometry (SSG), equal and different sensor ranges were considered and the performance is increased.	The FIM model which reduces the source localization problem	The same model is implemented for the heterogeneous models with optima trajectory for moving RSSD sensor placements.
EEFFL [36]	Proposed a scheme based on forest area which is split into grids and they are named active, medium active, and low active where each grid consists of eight neighbor grids, support vector machine (SVM) range-free localization algorithm and greedy forwarding algorithm is used for transferring data between grids and interior nodes.	The proposed model reduces the localization error and higher accuracy of zone prediction enhances the throughput and packet delivery ratio.	The same method is implemented in the heterogeneous model and the life of a highly active grid is reduced. It is a great concern that the low activation energy is not used effectively.
Resilient Routing algorithm [37]	Proposed a resilient routing algorithm for a large-scale sensor network. Instead of detouring the failed path they use a homotopy as a new topological concept for the creation and evaluation of different paths available in the network	Proposed routing schemes performs well in correlated failure models and the Packet delivery ratio is increased due to homotopy type.	Delivery rate under the independent node failure model for the surface networks to be checked with resilient routing protocols.
FGSA [38]	FGSA approach was designed by combining fractional theory and gravitational search algorithm employs to find the optimal cluster head in an iterative fashion	The proposed technique increased the network lifetime and decreases the delay.	If the sink node is mobile a heterogeneous node can be optimized for better performance.
EDMHT-LEACH [39]	The proposed approach employs a dynamic mechanism for data transmission to the cluster head, which then sends the data to the base station.	The proposed technique has increased the network's longevity, stability, and throughput.	The same model is implemented for the heterogeneous models with other parameters like quality included with the mobile sink.
LSR [40]	The multi-objective WSN optimization problem was specifically addressed by the author's novel Lightweight Secure Routing (LSR) technique for managing WSNs.	In the hybrid deployment strategy, 40% of the nodes were distributed uniformly, providing good coverage around the edges, while 60% of the nodes were distributed using two-dimensional Gaussian distribution to minimize the energy hole problem for high node density networks.	A breach in data security might occur if any sensor node is hacked since the event data kept can be obtained by an attacker. Blockchain-based trust architecture can be used to increase data security. Storing the event data on a blockchain would boost data security since a blockchain is an immutable record.

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AEMP [41]	The Addition Encouragement Multiplication Punishment (AEMP) model is employed to carry out this trust-based energy routing computation. The Mixed Integer Linear Programming technique is used to further optimize the WSN model, resulting in a lower energy consumption model (MILP).	Throughput has increased by 30%, residual energy has increased by 13%, and network lifespan has increased by 15%, correspondingly.	Instead of focusing just on trust value, energy value, and dependability, the selection of the best path in a WSN can also be taken into account additional metrics including packet transit time, distance, and hop count.
DST & TDoA [42]	In an implementation of Dampster Shafer Theory (DST), the vulnerability span ordinarily addresses probability and is replaced by the limits of conviction and credibility.	The proposed method has very low latency and less computation power.	Here for getting higher accuracy other detection algorithms can be incorporated.
CLCC [43]	Proposed a cross-layer congestion control mathematical model between the transmission layer and MAC layer is applied with fuzzy sliding mode control	CLCC regulates the queue length and increases the speed and stability in terms of convergence delay, packet loss, and throughput.	Here the network Cross-layer congestion with fuzzy logic can be optimized for better performance.
security protocol by means of ECC [44]	Proposed a security protocol developed with elliptic curve cryptography and providing hash function in a protective manner of key exchange. A normal server and the master server are implemented and calculated the cost,	Security and the efficiency of communication are increased.	Using a centralized server creates an issue in terms of security. So, an enhanced protocol needs to be developed.
SEOF [46]	They proposed a sleep scheduling-based energy-optimized framework that works with energy-efficient cluster head selection and sleeps scheduling methodology is addressed for closely located sensors based on the threshold	The proposed model stability period of the network is 35.3% and 216% in case I and case II respectively.	If the sink node is in mobility and the placement of the sink node through this methodology is to be addressed and optimized for better performance.

3. ANALYSIS OF DISTINCT ROUTING PROTOCOLS

This section compares and analyzes various clustering and routing protocols, as well as approaches such as cluster head selection, relay node identification, mobile sensor node placement, and localization by improving end-to-end latency, packet delivery ratio, energy consumption, and network lifespan by using FGSA, TKFCM, SEOF, LEACH Flion, EDMHT-LEACH, DARE-SEP, SAAFA, IPA, ARIMA, RNN-LSTM. In the FGSA model, the delay is about 0.1266 based on time, throughput is around 0.222 based on time and the energy consumption in the network is around 0.0330 based on time. In the SEOF algorithm, the throughput for the packets is around 105519 where the network life is increased by 35.3%. In LEACH Flion and EDHMT-LEACH delay is around 0.1245 and the network lifetime is increased by 88.43%. In the DARE-SEP the network lifetime is increased by 10% when compared to other protocols. In the SAAFA algorithm, the network life is attained at around 98.63%. In the IFPA algorithm and ARIMA modeling, the throughput is around 97% and 82% respectively. If nodes are arranged in a cluster, energy consumption of the nodes is reduced to 65% in consumption which increases the network lifetime. In the RNN-LSTM protocol, the throughput is around 190ms, and there increases the network lifetime and efficiency of the

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network. By comparing every protocol discussed above they are more energy efficient with high reliability.

3.1. Comparison with Energy Consumption

Table 2 compares the energy consumption of the EEEA-CRS protocol with FGSA, EDMHT-LEACH, MOGA, and SAAFA protocols. Figure3. Illustrates the graphical results between the existing protocols like EEEA-CRS, FGSA, EDMHT-LEACH, MOGA, and SAAFA. When the number of nodes in the FGSA protocol is raised from 100 to 500, the total energy consumption ranges from 128.23 to 289.18 (mJ). The overall energy usage in EDMHT-LEACH has literally risen for 100 nodes it is 114.71 and for 500 nodes to about 226.74 (mJ) respectively. MOGA's energy usage is around 78.16 for 100 nodes and 180.31 (mJ) for 500 nodes. Whereas in SAAFA it is around 59.17 for 100 nodes, it has risen to 146.63 (mJ) for 500 nodes. EEEA-CRS performs well with a lower energy consumption of 32.83 to 119.23 (mJ) when the number of nodes is raised from 100 to 500, whereas other protocols like FGSA, EDMHT-LEACH, MOGA, and SAAFA have greater energy consumption when compared to EEEA-CRS and would shorten the network life.

3.2. Comparison with Network Lifetime

Table 3 compares the network lifespan of the EEEA-CRS protocol with that of the FGSA, EDMHT-LEACH, MOGA, and SAAFA protocols. Figure 4. Illustrates the graphical results between the existing protocols like EEEA-CRS, FGSA, EDMHT-LEACH, MOGA, and SAAFA. When the number of nodes in the FGSA protocol is raised from 100 to 500, the total lifetime ranges from 4603 to 2217 (rounds). The overall network lifespan in EDMHT-LEACH has literally decreased for 100 nodes and it is 4225 and for 500 nodes to about 22821 (rounds) respectively. MOGA's protocol lifespan is around 4663 for 100 nodes and 3582 (rounds) for 500 nodes. Whereas in SAAFA it is around 5339 for 100 nodes, it has decreased to 3727 (rounds) for 500 nodes. EEEA-CRS functions well when there are between 100 and 500 nodes, with a high network lifespan of 5767 to 4991(rounds) respectively.

3.3. Comparison with End-to-End Delay (E2D)

Table 4 compares the end-to-end latency of the EEEA-CRS protocol with that of the FGSA, EDMHT-LEACH, MOGA, and SAAFA protocols (E2D). Figure 5. Illustrates the graphical results between the existing protocols like EEEA-CRS, FGSA, EDMHT-LEACH, MOGA, and SAAFA. When the number of nodes in the FGSA protocol is raised from 100 to 500, the total E2D ranges from 6.03 to 10.65(s). In EDMHT-LEACH the delay has literally raised for 100 nodes it is 5.44 and for 500 nodes by about 9.13(s) respectively. MOGA's protocol delay is around 4.30 for 100 nodes and 8.14(s) for 500 nodes. Whereas in SAAFA it is around 2.42 for 100 nodes, it has raised to 6.20(s) for 500 nodes. In comparison to other protocols such as FGSA, EDMHT-LEACH, MOGA, and SAAFA, EEEA-CRS performs well when the number of nodes is extended from 100 to 500, with a PDR ratio of 0.89 to 3.15, respectively.

3.4. Comparison with Packet Loss Ratio

Table 5 compares the packet loss ratios of the EEEA-CRS protocol with those of the FGSA, EDMHT-LEACH, MOGA, and SAAFA protocols (PLR). Figure 6. Illustrates the graphical results between the existing protocols like EEEA-CRS, FGSA, EDMHT-LEACH, MOGA, and SAAFA. When the number of nodes in the FGSA protocol is raised from 100 to 500, the total loss ratio ranges from 6.25 % to 19.26 %. In EDMHT-LEACH the loss ratio has raised for 100 nodes which are 3.29 % and for 500 nodes to about 13.23 % respectively. MOGA's protocol packet loss is around 2.46 % for 100 nodes and 8.27 % for 500 nodes. Whereas in SAAFA it is around 1.14 % for 100 nodes, it has raised to 2.67 % for 500 nodes. EEEA-CRS operates well when the number of nodes is raised from 100 to 500, with a PLR ratio ranging from 0.22 % to 2.67 %, whereas other protocols such as FGSA, EDMHT-LEACH, MOGA, and SAAFA have larger packet loss ratio.

Table 2 Comparison of Protocols in Terms of Energy Consumption (mJ)

No. of Node	FGSA	EDMHT-LEACH	MOGA	SAAFA	EEEA-CRS
100	128.23	114.71	78.16	59.17	32.83
200	145.83	149.29	92.28	72.37	58.09
300	200.15	161.48	123.75	101.19	79.35
400	225.32	192.11	161.49	127.20	90.76
500	289.18	226.74	180.31	146.63	119.23

Table 3 Comparison of Protocols in Terms of Network Lifetime (Rounds)

No. of Nodes	FGSA	EDMHT-LEACH	MOGA	SAAFA	EEEA-CRS
100	4603	4225	4663	5339	5767
200	4531	3637	4134	5027	5662
300	3624	3206	3941	4718	5405
400	3130	3875	3736	4303	5115
500	2127	2821	3582	3727	4991

Table 4 Comparison of Protocols in Terms of End-to-End Delay

No. of Nodes	FGSA	EDMHT-LEACH	MOGA	SAAFA	EEEA-CRS
100	6.03	5.44	4.30	2.42	0.89
200	7.21	6.70	5.44	3.34	1.31
300	8.43	7.31	6.17	4.70	2.13
400	9.35	8.74	7.37	5.23	2.80
500	10.65	9.13	8.14	6.20	3.15

Table 5 Comparison of Protocols in Terms of Packet Loss Ratio (%)

No. of Nodes	FGSA	EDMHT-LEACH	MOGA	SAAFA	EEEA-CRS
100	6.25	3.29	2.46	1.14	0.22
200	7.37	5.41	3.10	2.76	0.26
300	10.52	6.77	5.65	4.39	1.28
400	15.12	9.39	6.40	5.53	1.73
500	19.26	13.23	8.27	4.01	2.67

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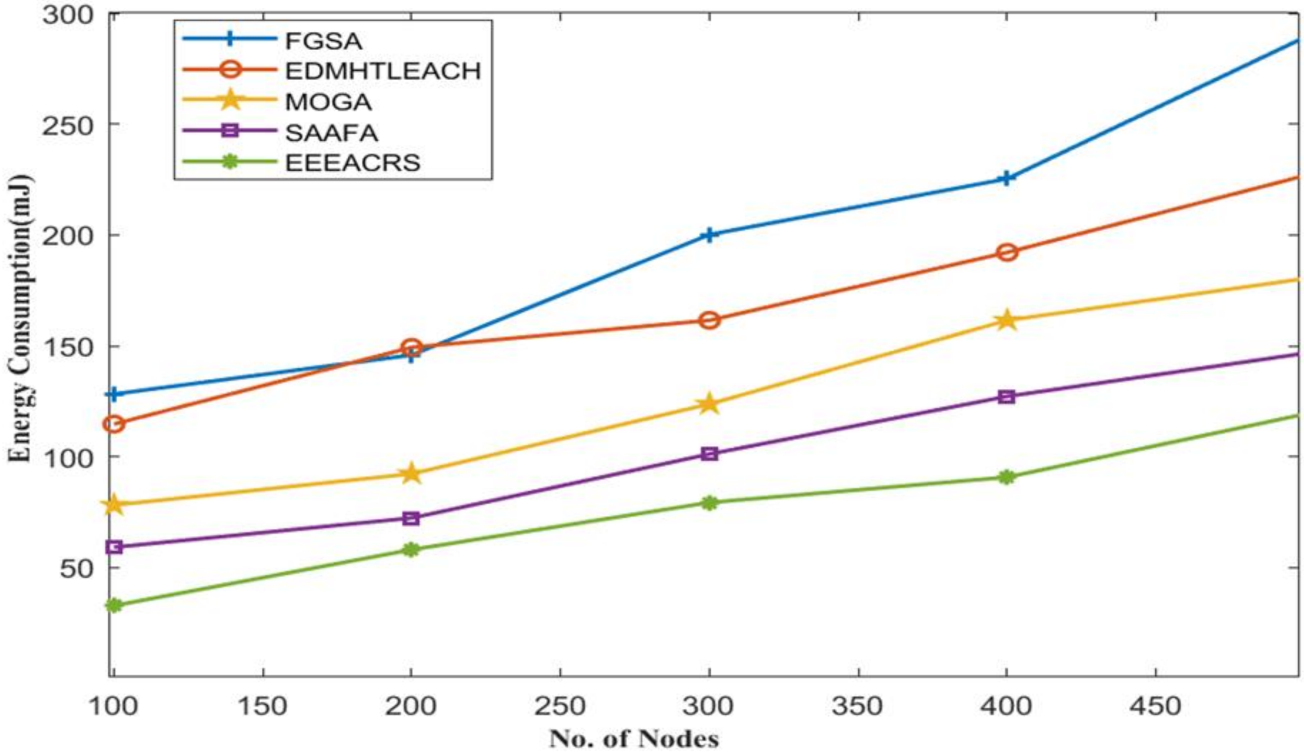

Figure 3 Comparative Results for Energy Consumption

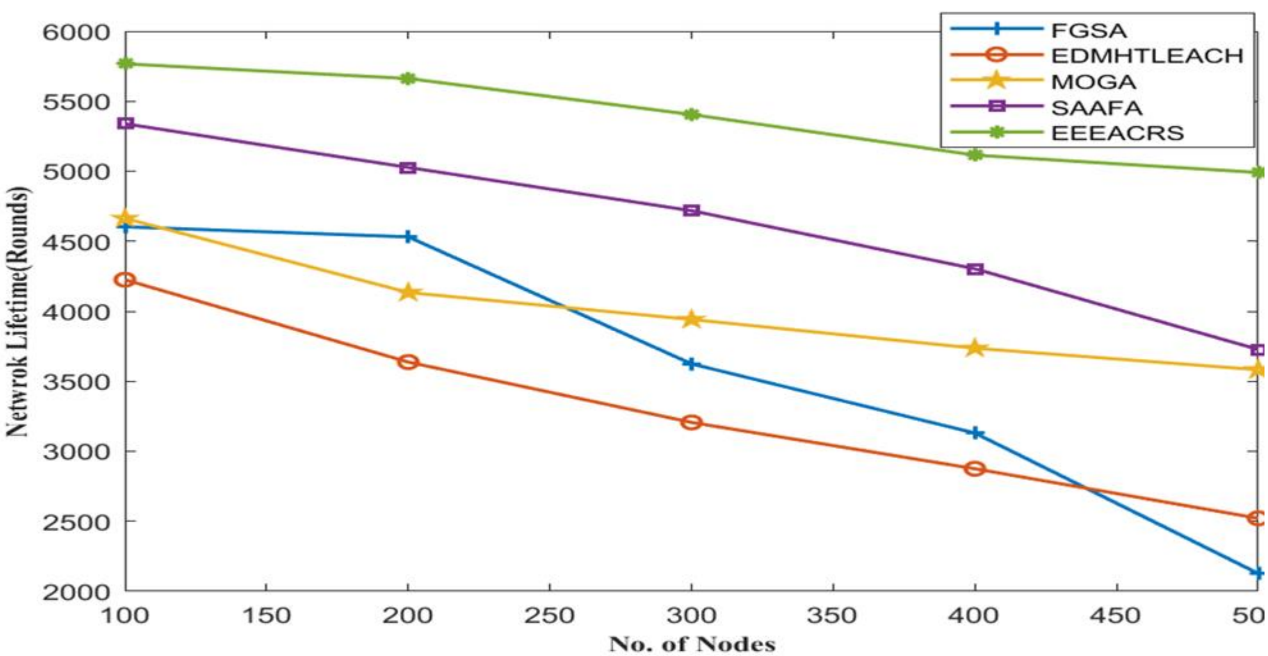

Figure 4 Comparative Results for Network Life Time

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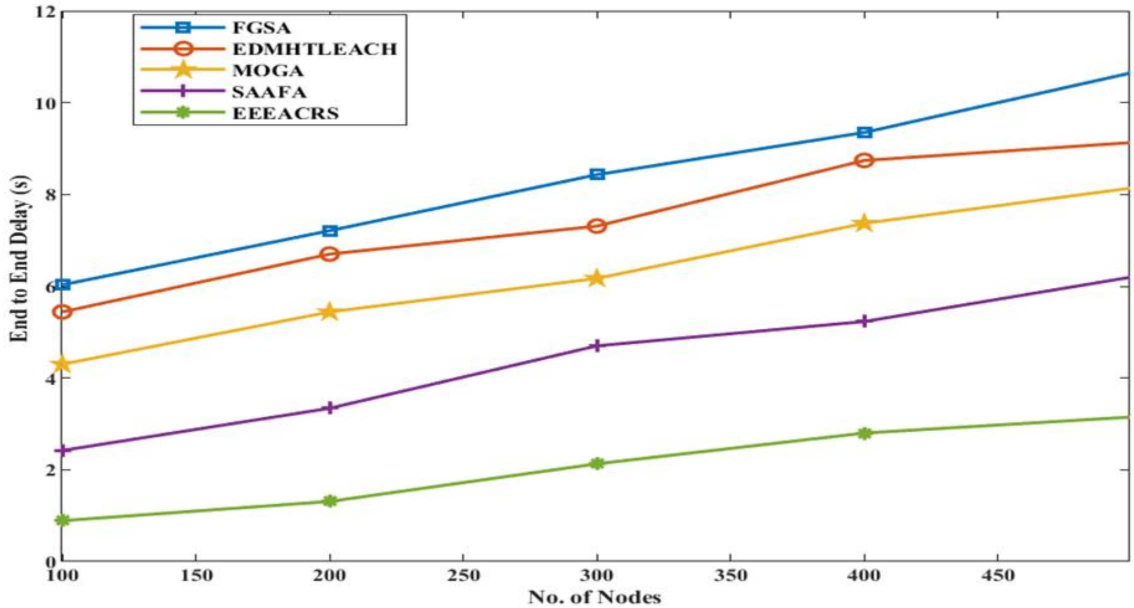

Figure 5 Comparative Results for End-to-End Delay

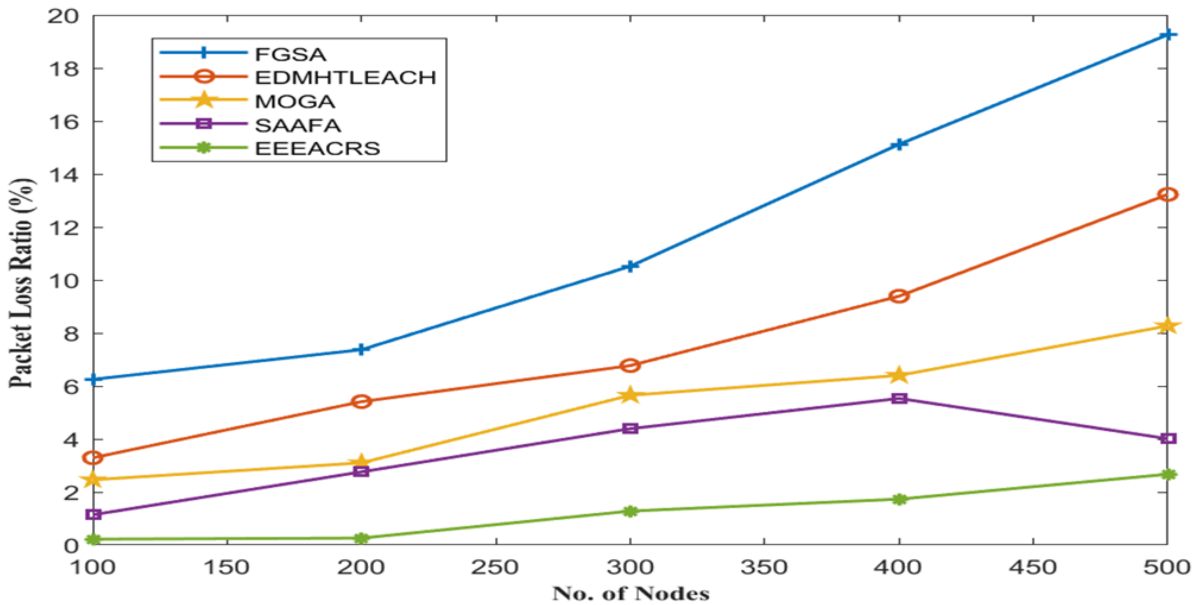

Figure 6 Comparative Results for Packet Loss Ratio

4. PROPOSED ARCHITECTURAL FRAMEWORK FOR BORDER SURVEILLANCE

Rajeev et.al.,[1] proposed an architectural framework for intruder detection this model is for detecting the attacker but not for tracking the attacker. A raspberry microcontroller 3, infra-red sensor, ultrasonic sensors, camera sensors and ZigBee modules are added to detect the attacker. When the sensor node's energy is exhausted, the network lifespan gets reduced. To increase the lifespan of the network and also to track the attacker, an architecture framework for the border surveillance system is proposed and shown in Figure 7. In this framework, heterogenous sensor nodes are randomly deployed over the given area. Four kinds of sensors like vibration sensors, human body heat detection sensors, motion detection sensors, and camera sensors for the surveillance system. The ks0272 key studio analog piezoelectric ceramic vibration sensor is used due to its efficiency and for the thermal body sensing Omoron D6T-32-01A sensor is used. The HB100 radar motion detection sensor is used for the identification of the distance of the intruder in that particular area. Then an ArdoCam IMX477 12MP camera sensor for Raspberry Pi 4 and Jetson Nano Xavier, IRcut metal base, and 2 digital servos for the movement of the camera to find the intruder's direction, infrared rays are used for night vision capturing. Once there is a depletion in the sensor node's energy below the threshold value a mobile charger is used to charge the sensor nodes for longer connectivity. All the data collected is transferred to the LEO satellite which is in mobility over the given area. Once the data is collected in the satellite through edge computing technology decisions were taken and those data will be transferred to the base station. Information is processed in the control center and they implement the troops for surveillance.

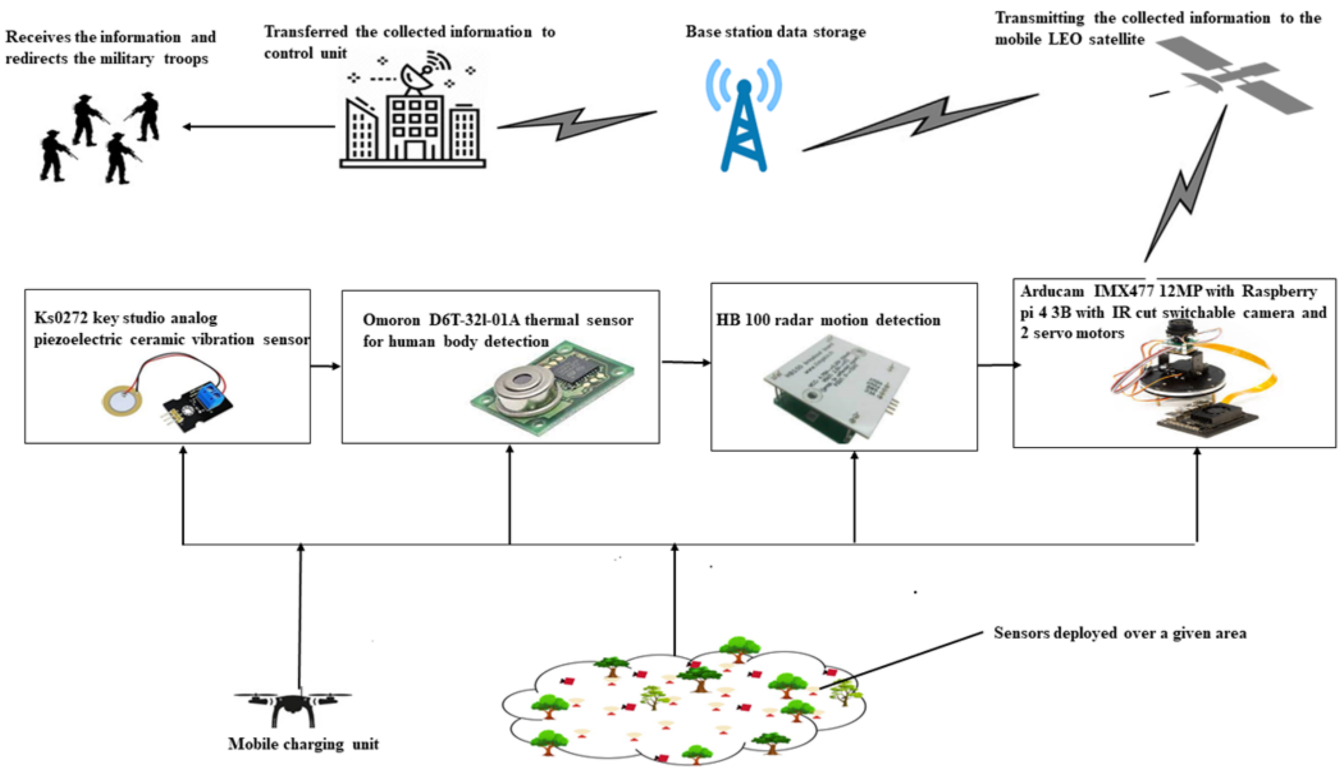

Figure 7 Framework Architecture for Border Surveillance System

5. CONCLUSION

This paper presents an overview of border security surveillance and intruder detection. In this survey, various algorithms, methods, and scenarios used for border surveillance systems are discussed with different issues and challenges. Then, analysis of distinct clustering protocols and routing protocols for identifying the mobile sink nodes and their localization, optimization of route traversing and reducing delay, energy efficiency, and increase the throughput of the network to maximize the network lifetime. An architectural framework for the security of border surveillance is presented in this article we can't state one protocol is better than another since sensor networks are application specific. Comparison and analysis are performed on various protocols like FGSA, EDMHT-LEACH, MOGA, SAAFA, and EEEA-CRS. Based on few criteria like network lifetime, packet loss ratio, end-to-end delay, and energy efficiency. The EEEA-CRS protocol performs well. Hotspot problems have been addressed by several methods, including dynamic clustering strategies, even and uneven clustering algorithms. Protocol's have encountered other problems including overhead and connection while attempting to address the hotspot problem. Future directions for this study include altering one of the above routing protocols such that the updated protocol can provide a more effective clustering procedure for wireless sensor networks which can overcome the hotspot issue for the overall system and increase the lifetime of the wireless sensor network.

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