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A Review of Wireless Sensor Network Data Aggregation Techniques' Privacy and Energy-Efficiency

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Abstract – Wireless sensor networks (WSNs) are made up of tiny sensor nodes dispersed across a large area for the purposes of sensing and data processing. They can't store much information in their memory and have a small amount of energy. Extensive amounts of power are used during the sensing, processing, transmission, and receipt of sensed data. That's why these sensor nodes are acting up. It is possible to extend the life of a network and circumvent these constraints by employing a variety of data aggregation strategies. With data collecting, the sink node collects and aggregates relevant data in an effective manner while minimising energy use. The lifespan of the network may be lengthened, and redundant data can be eliminated. This study provides a comprehensive overview of energy-efficient dependent data aggregation strategies for wireless sensor networks. Different data aggregation strategies in wireless sensor networks (WSN) are addressed, along with their energy efficiency and privacy implications.

Keywords – Data Aggregation, WSN, Review, Energy Efficiency and Privacy.

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INTRODUCTION

Wireless sensor networks, an ad hoc network made up of a large number of sensor nodes, are used to keep tabs on the real-world environment or the present health of a piece of machinery. There has been a rise in the use of WSN in many kinds of fields, including the military, industry, and the general public. Subsequent to deployment, the sensor nodes self-organize into a tree topology with the base station at its centre. In a topologically-sound direction Within a predetermined time frame, sensor nodes collect and transmit various data kinds to the base station (BS). The lifespan of sensor nodes in a network is affected by the amount of energy consumed during transmission. As a result, the approach of data aggregation has been widely used in WSN as an influential way to reduce the volume of data transfers. TAG[1] organises each node into an aggregation tree to lessen communication overload and increase the lifespan of the network. A hostile node may quickly decrypt and access the essential information of other nodes, hence TAG lacks data security in terms of privacy. To deal with and fix these issues, the Slice-Mix-AggRegaTe (SMART) algorithm[2] was proposed. Each SMART node, in order to protect the privacy of its constituent nodes, divides its data into a limited number of slices and sends those slices to their neighbours through the network. In addition, the slicing approach results in an enormous quantity of communication, which uses a lot of energy. With the proposed PECDA[3] and ESMART, data slicing is only performed on leaf nodes, reducing both energy usage and communication overhead. In a big network, the data slicing process inherently involves a high volume of communication[4]. An additional reduction in the number of nodes transferring their data bits can reduce the network's energy consumption, which is helpful for the goal of safeguarding and ensuring data privacy.

LITERATURE REVIEW

WSNs, or wireless sensor networks, have been the centre of several discussions recently. Because of the importance of constant monitoring, wireless technology is being included more frequently in the building of sensor networks. Sensors are everywhere, yet their widespread deployment has led to complications in many areas, including but not limited to: energy, routing, security, coverage, latency, architecture, and so on. These tiny nodes are tasked with continuously monitoring the region of interest under the established protocol standards

and relaying that information to the sink. There's only room for one battery, and the sensor nodes don't have any way to swap them out or charge them. An interruption in data collection over some or all of an application area is possible if a power failure affects even a single sensor node in a network. All of the application's nodes may set themselves up to share information and work together with minimal human intervention. [5].

The author suggested the designated route (DP) approach as a means of providing a technique of data aggregation across WSNs that is both more balanced and efficient in terms of its use of energy. The DP strategy settles on a set of paths and then uses a round-robin approach to execute them so that all of the nodes may take turns shouldering the responsibility of data collection and transfer to the sink. This allows for more equitable distribution of the work load[6]. Despite this, the total quantity of energy that is wasted continues to increase.In response to a request from an application, data gathered by nodes in a region was transformed into an aggregate form, such as an average of the temperature and humidity. The data aggregation process combines observations from several nodes at an intermediate level before sending the combined data to the sink. In order to guarantee precision, the nodes in the observation field provide some redundant data. Data collected from several sources may be combined using appropriate data aggregation techniques, hence reducing the need for duplicate data exchanges. The task of gathering data from the other nodes and performing the aggregation procedure is assigned to the cluster head/central coordinator or to any intermediate node. [7], [8].

An author has provided a data aggregation system that is efficient in terms of energy consumption, secure, highly accurate, and scalable (EESSDA). Building secure channel and slicing technologies to enable safe data aggregation is the central tenet of EESSDA, which aims to achieve this goal through its implementation. The EESSDA approach does away with the need for processes involving encryption and decryption in order to conserve power and guarantee the accuracy of the data that has been acquired. In contrast, EESSDA does not require any extensive implementation of inter-node information exchange, which results in networks that are very scalable[9]. Data aggregation refers to the process of combining data from several nodes at an intermediate level and transmitting the resulting information to the sink. When it comes to accuracy, a certain amount of redundant data is required, and the nodes in the observation field are in charge of providing that. It is feasible to decrease the quantity of unnecessary data transfers by merging data from several sources, provided that proper data aggregation techniques are utilised. The cluster head/central coordinator or an intermediary node is in charge of gathering data from other nodes and performing the aggregation function. One of their obligations is this.

In the context of the present research, there are several advantages to using a mobile element rather than a multi-hop routing to mechanically gather and transmit data from a sensor network. Taking use of the network's intrinsic mobility, the author outlines a method for gathering data for WSN. A mobile collector, or M-collector, is a robot or truck equipped with a large battery and a transmitter[10]. That way, as it goes across the area, the mobile collector may act as a kind of mobile base station, gathering information along the way. After getting periodic updates from the static sink, the M-collector polls all nearby sensors whenever it moves, and finally sends the accumulated data to the static sink.The paper's authors present a strategy for data collection[11] in WSNs that incorporates prediction models. The expense of transmitting information can be reduced by omitting unnecessary messages. Less energy is needed to keep the nodes online as a direct result of this. As a means of increasing productivity as a whole, the cluster heads in that region rotated at just the right moment. The article's authors[12] focused primarily on data aggregation inside wireless sensor networks. One form of attack we look into in this work is the deliberate insertion of spoofed data by malicious nodes. This method proposes end-to-end privacy, which checks at each link in the chain, as a possible countermeasure. Because of this, less effort is required from the sink node. The MicaZ and TelosB mote underwent the identical implementation procedure, and the findings were confirmed by tests and computer simulations. Researchers in this paper worried mostly about how much power wireless sensor networks will consume. Intra-balanced LEACH is an improved form of the LEACH routing protocol that they developed (IBLEACH). Using IBLEACH, the authors[13] of this work were able to successfully equalise the energy consumption of the cluster's nodes. Both the longevity and the power consumption of the procedure's findings were compared to those of alternative methods.

The WSN's designers relied on an innovative technology known as distributed Power Scheduling (PS) to guarantee that the network was continually monitored[14]. This method takes use of the fact that sending data takes far less time than reorganising a sensor network. The EECBSS scheme is a cluster-based scheduling method proposed by the authors that finds a balance between energy efficiency and network lifetime[15]. The EECBSS approach is employed here. These are the three parts: After we finish the other processes, we examine at how much energy is still remaining and utilise that to choose which CH topology to employ. The following scheduling approach is a TDMA schedule allocation designed to avoid collisions. The final stage was to apply an energy consumption model to the networks having the largest excess electricity[16]. The authors proposed an energy-efficient sleep schedule for cluster-based aggregation in order to maintain high

data transmission speeds while minimising power usage. This action met both of these goals

The author of recommended a polling-based mobile collection technique for WSN[17]. An optimization problem for constrained mobile data gathering through relay hops is presented in this research (BRH-MDC). It was chosen to employ a small number of sensors as polling locations, with each sensor keeping a copy of the aggregated data locally for a short period of time before sending it to the mobile device in real time[18]. As long as the sensor is able to talk to these nodes, we know that the total number of hops for each data relay will remain constant. Two methods for deciding which sensors to query are also shown. The authors of suggest an LSW, a local wake-up scheduling approach based on an ant colony-based scheduling strategy, to extend the operational life of sensor networks[19]. The method includes two stages: the first locates a group of SNs that supplies complete coverage, and the second locates SN replacements that use up the least amount of energy in the network.

The author of presented a Velocity Energy-efficient and Link-aware Cluster-Tree (VELCT) approach for data collecting in wireless sensor networks (WSNs)[20], with the purpose of successfully mitigating the difficulties of coverage distance, mobility, latency, traffic, tree intensity, and end-to-end connectivity. The suggested Variable Extraction and Clustering Tree (VELCT) starts building the Data Collection Tree (DCT) at the node representing the cluster head. The data collecting node is responsible for receiving data packets from the cluster leader and transferring them to the sink during this iteration of the DCT. Previously, the data gathering node was involved in sensing[21]. The suggested VELCT system makes effective use of DCT, which minimises energy consumption, shortens end-to-end latency, and reduces traffic in the cluster head of WSNs. One of the VELCT algorithm's main features is its ability to build a simple tree structure. This decreases the amount of resources used by the cluster leader and prevents clusters from forming too frequently. Furthermore, it assures that the cluster continues to work for an extended period of time.

The majority of extant data aggregation techniques use either a cluster-based or a tree-based topology.

Tree-Based Algorithms

Term of ‒slicing-mixing‖ and SMART algorithm was primarily put forth by He et al. [22]. Every node is sliced its raw information into some parts andtransfer them to nodes without leaf. Each node mix accepted information with self-data and transmit recent aggregated output to its pre-existing nodeafter distribution of data pieces. Lastly every aggregation results is received at base station in a network. But, it becomes compulsory in providing retention of privacy of information that was transferred by nodes with non-leaf types. Because of nodes that are labelled as non-leaf aggregates information of its child nodes to produce combined outcomes. Previous data of non-leaf nodes isavoided in leaking it to remaining nodes. Hence PECD Ascheme and ESMART scheme have given respectively by Li et al. [24] and Wang et al. [23]. To resistmaliciousthreatstogethertheyhadmerely done leaf node‘s data slicing and sent these pieces of information to the irnodesinneigh bour along path ways securely.Depending on polynomial functions Ozdemir et al. [25] suggested a data aggregation protocol PRDA, Nodes of sensor uses polynomial functions in representing those information and to hide real information it transfers of polynomial function‘s coefficients to non-leaf nodes. Based on homomorphic encryption in [26] PDKP protocol was suggested by Zhou et al. So as to secure confidentiality of information and for sensing integrity of data it uses symmetric in terms of coding and decoding cryptography-dependent secured privacy MAC‘s homomorphism and holomorphic. For dynamically selecting amount of data pieces and its sizes that enhances behaviour in slicing of data Hua et al. provided an idea of ASSDA protocol in [27].

Cluster-Based Algorithm

To decrease energy consumption CPDA scheme in[22] uses protocols of clustering and algebraic characteristics of polynomials. In an algorithm providedbyOzdemiretal.[28]IPHCDAprotocol,‒anelliptic curve cryptography dependent homomorphicencryption isimplimentedin achieving hierarchical aggregation of data. Because of end-to-end data aggregation information integrity is guaranteed and by key encryption confidentiality of data is assured. LPDA was suggested in [29]. Cluster head delivers a base value to other nodes before data aggregation, then such nodes primarily takesoutbasevaluefrom theirowninformation,and later adds a random number that is produced by themselves. An aggregation algorithm, whichassigns specific encryption keys for every individual node to ensure security of data is handed over by Elhoseny et al. [30]. BinaryString which is produced byellipticalcurve encryptionalgorithm,IDnumberof these nodes, distance between this node to cluster head and index of transmission is contained by encryption keyof a node.‖ Based on cluster privacy- preserving, in [31], Fang et al. had given a model about data aggregation scheme CSDA. It implies slice-assemble technology to get better data privacy and flexibility. As scale of network changes number of pieces will vary too. Various emergingaggregation techniques are provided last few years time. But, to ensure sensory data security existing aggregation techniques exhaust huge energy.

CONCLUSION

A comprehensive review on privacy and energy efficiency based data aggregation in a WSN is presented in this paer. As much of energy is exhausted in course of transmitting, processing, and

accepting sensed information, data aggregation has resulted significantly. In collecting and aggregating sensed information and eliminating redundancy, data aggregation has played an important role. It helps in decreasing traffic on network and consumption of power, thereby improving network lifespan and its efficiency. In a tree-based aggregation Power Consumption is low throughout data transmission as compared to grid based or cluster aggregation.

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