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Abstract. The wireless network of sensors is a system of interrelated nodes with cooperative working ability as well as synchronized processing, which gives it an advantage over other existing systems in terms of lesser cost, higher flexibility, and easier deployment in different terrains. A base station, also known as sink, serves as a go-between for users and the network, allowing users to request information from the sink and receive it back. It has been used in various fields like earth sensing, habitat monitoring, and image transmission. The multimedia capabilities of WSN makes it more robust. However, due to the limited processing power during image transmission, it is evident that energy consumption should be reduced in order to make it more efficient. And it's also equally important that transmitted images across the networks should be secure from external threats & Vulnerabilities. Different protocols are designed to preserve the energy so that the same can be utilized for further transmissions and enhancing security. In this paper, a comprehensive review of different techniques used in energy efficient image transmission has been done, as well as a comparative analysis of all these techniques through which we can find the best suited technique.

Keywords. WSN, DWT, EACIT, image transmission

INTRODUCTION

Wireless sensor networks are systems that are wirelessly connected. These networks are individually equipped with a variety of sensors such as humidity sensors, pressure sensors, and sometimes motion sensors which are the rudimentary characteristics of WSN over others[3]. The importance of wireless sensor networks is increased due to their characteristics, which include both homogeneity and heterogeneity of nodes. It retrieves the data from the surrounding area and passes it on to the centralized location, where further processing of the data is done [4]. Its utility is diverse, ranging from health care monitoring to earth sense.

In healthcare, wireless sensor networks play an important role in remote care monitoring. Nowadays, due to severe diseases, patients require continuous monitoring, which is not only good for their health but also generates data that gives doctors insights about the patients. This is especially important for elderly patients who require continuous supervision. WSN creates a real-time environment that provides both efficiency and robustness to the healthcare system. Moreover, WSNs can be employed in disaster-prone areas to detect seismic activity. Sensors can be placed near fault lines to detect P-waves and S-waves generated from the epicentre due to divergence, convergence, or transformation. Using modern tools, they can predict earthquakes based on the Richter scale.

In image transmission, it is used for transmitting the images across the nodes, but images require a large amount of data to be transmitted, which includes colour information, image metadata, and pixel data. Consequently, it leads to larger file sizes, which consume more energy [6]. Secondly, signal strength and transmission distance also play an important role in energy utilization because weaker signals consume more energy compared to stronger signals. As it works at lower power, transmitting images over larger distances drains the battery of the sensor nodes, which require energy to continuously work to process the image [8].

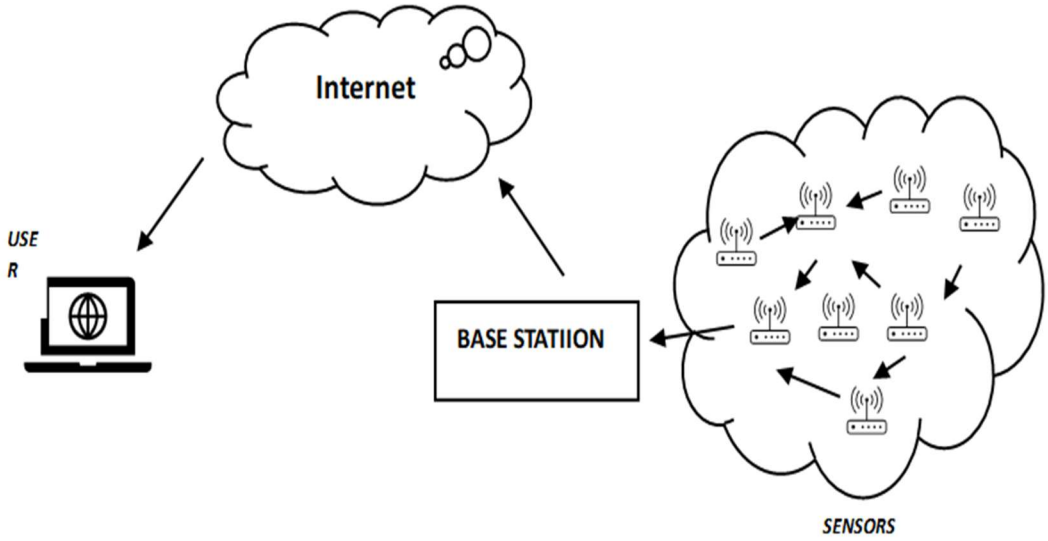

FIGURE 1 *Wireless Sensor Network*

Image compression techniques play a significant role in reducing file size by compressing, but they also consume energy.

Image transmission can be achieved through different techniques. Firstly, indirect transmission, images are transferred using prevailing wireless communication protocols like Wi-Fi and ZigBee. However, this method is limited to small-scale transmissions. Another common way of transmitting images is through compression techniques [8]. In this method, images are compressed either at the sensor node or at the processing node. Compression reduces the size of the image data, which not only reduces the transmission time but also leads to less energy consumption.

This paper is structured systematically. In Part II, a comprehensive review of the existing literature has been conducted. In Part III, a comparative analysis has been performed to determine the best-suited technique. In Part IV, this paper concludes and proposes its approach after identifying the limitations in previous studies.

LITERATURE REVIEW

This section discusses the different techniques adopted to transmit the images across WSN nodes and energy-efficient techniques to reduce energy consumption while transmission.

The Energy Aware Cooperative Image Transmission (EACIT) method that is suggested in the research expands on existing established methods and includes fresh concepts to enhance the transmission of pictures via WSNs. EACIT uses spatial multiplexing to improve network performance and calculates the maximum transmitting power necessary to accomplish the desired bit error rate in each hop. The simulation results show that EACIT works better than current algorithms and can cut energy use by about 33%[1].

To strengthen security, decrease delays, and improve the packet delivery ratio during wireless picture transfer, this research suggests a secured transmission framework. The aim is to enhance the security of transferred information against attackers while minimizing energy consumption. To achieve this, the paper suggests using a cluster-based encrypted routing technique and the secure routing algorithm known as an elliptic curve hill cipher. This method displays a high level of efficiency in comparison to other algorithms like HEED, ELHOSENY, LEACH, and STRM, including the lifetime of the network, delay time, packet delivery proportion, and usage of energy.[2].

The suggested system utilizes wavelet-based image compression and steganography as an approach to a technique for energy-efficient picture transmission over WSNs. The skin tone region of photographs is recommended for steganography because it can be used to conceal sensitive information. To communicate compressed images efficiently and save energy, a team effort is used. The limited resources of the nodes are a major point of emphasis in the paper about the significance of energy saving in WSNs. Moreover, the large amount of data traffic generated by image transmission can rapidly deplete the energy of the nodes, thus shortening the network lifetime. Overall, the paper provides a useful approach for efficient image conveyance over WSNs while addressing security concerns[3].

Energy conservation is a goal of the suggested Priority based Picture transmission technique. They have adopted the CDF 9/7 Discrete Wavelet Transform (DWT) to perform the wavelet decomposition. It transmits wavelet coefficients as per priority. The wavelet image compression allows the priorities-based data packet to be arranged, and the sub-bands were prioritized as per the importance of their output. Levels have been set as '0' for higher priority and subsequently '1' etc., for further priorities. It works on the request-based scenario, in which a request has been initialized which is further facilitated by the intermediary nodes[4].

The proposed approach advocates the consideration of energy consumption and network lifetime in wireless networks comprising sensors for transmitting data in real-time scenarios. To achieve these objectives, energy-efficient techniques, such as image compression, are implemented to reduce the energy consumption, by the sensor nodes. In this context, this study elucidates the utilization of JPEG2000, which employs the DWT and EBCOT, to offer a practical set of features that were previously unavailable. The effectiveness of the suggested image compression strategy is then evaluated based on energy usage and image quality. Simulation findings show that the suggested technique optimizes network lifetime and minimizes memory needs by examining the functional impact of each parameter of the distributed image compression algorithm. These results suggest that JPEG2000 can be used in WSN to achieve energy-efficient image compression.[5].

The method that is suggested in this paper concentrates on choosing the number of collaborative sensors for each packet transmission to achieve the best image quality feasible within a constrained transmission energy budget. The suggested method has been contrasted with the most recent collaborative transmission scheme described in the WSN literature. The experimental findings demonstrate that the proposed method can deliver an image quality that is approximately 2dB higher than the current collaborative transmission scheme while consuming the same amount of energy[6].

This paper emphasizes the importance of error concealment (EC) as a powerful mechanism for reconstructing distorted multimedia data as closely as possible to the original, without increasing bandwidth consumption or causing delays from retransmissions. We describe EC and multipath transmission in the context of WSNs, with a focus on image-sharing applications. Specifically, we have modified the EC method proposed in previous work to manage block and pixel losses in WSNs. Our suggested EC technique uses a discrete wavelet transform (DWT) to embed scaled-down copies of the original image into itself, to mitigate degradations in a backwards-compatible manner. We also investigate the impact of using a Forward Error Correction (FEC) scheme to correct mistakes and losses caused by unreliable channels[7].

The approach dubbed Image Subtraction with Quantization (ISQ) is suggested in this research as a way to extend the useful lifetime of wireless sensor networks while enhancing energy efficiency. The method involves sending only the changes in an image that exceeds a certain threshold value, which is then quantized and sent to the destination where they are recomputed with the stored image. Simulation results show that ISQ increases the system lifetime by up to ten times while having comparable energy consumption to sending images without ISQ. The technique is rudimentary and uncomplicated to implement and does not require high computational power or battery consumption[8].

This manuscript presents EQ-MAC (Energy efficient MAC), a newly proposed contention-based, random access, MAC algorithm for picture conveyance in wireless sensor networks with good quality MAC. The primary goals of this approach are to reduce energy use and improve image quality. Additionally, a novel method of transmitting images at the application layer has been developed, which employs DCT-based technology to compress images and lower picture bandwidth. A dynamic priority mechanism has been used for picture data packets to properly align this layer with the MAC protocol and improve image quality while at the sink. The source node can choose which packets to delete when its energy level is low thanks to this prioritization mechanism.[9].

The technique for sending JPEG 2000 images through wireless point-to-point networks has been suggested in this article. The primary rationale behind this approach is to decrease the transmission as well as processing power consumption while still maintaining end-to-end Quality of Service (QoS). This technique addresses several challenges, including unfavorable wireless channel conditions, compressed multimedia data, and limited resources. To tackle

channel issues, the proposed method employs rate-compatible convolutional codes as the channel encoder, combined with JPEG2000 as the source coding standard. A simple source-channel coding and power control approach is utilized to adjust the number of layers, error resilience strategy, the transmission power level for each layer, channel coding, and source coding rate. The proposed technique is superior since it is versatile, optimal, and straightforward, all of which are fundamental attributes of effective multimedia transmission systems. [10].

Comparative analysis

TABLE 1. Literature Review of Existing Technologies

Year	Brief Description	Technology Used	Limitations
2022[1]	An EACIT-based method seeks to increase energy effectiveness by estimating the maximum transmitting power.	EACIT	Lack of relay optimization technique, less saving.
2020[2]	A secure encryption scheme and a transmission framework for wireless image transfer in traffic monitoring using wireless sensors.	Elliptic Curve Cryptography, Hill Cipher, Cluster Based Routing	As a result of using image data as well as key images throughout the encryption process, the packet latency is somewhat increased.
2016[3]	lays out a workable plan for the energy-effective transfer of images using WSNs while addressing security concerns.	Steganography	Negligible decrease in overall image quality.
2012[4]	Priority Image Transmission (PIT), a unique energy-saving strategy, is suggested for Wireless Sensor Networks (WSNs). PIT uses wavelet image compression and gives compressed picture data certain prioritisations.	DWT	The algorithm's performance was not improved by exploring the use of multi-path routing.
2010[5]	It suggests an energy-efficient picture compression method for wireless sensor networks that makes use of the DWT, EBCOT, and JPEG2000 standards in order to prolong network lifespan and	DWT as well as EBCOT	Incompatible with the multipath routing**.**

	minimize memory requirements.		
Year	**Brief Description**	**Technology Used**	**Limitations**
2010[6]	An ensemble signal enhancement method for wireless sensor networks picture transmission that has minimal usage of energy.	Collaborative Signal enhancement, wavelet-encoded images	Node homogeneity assumption, Limited optimization complexity.
2010[7]	This paper evaluates error concealment and Reed-Solomon coding techniques for mitigating image distortions caused by channel and node failures.	EC algorithm and FEC algorithm	hardware/software impairment node failures packet losses across network.
2009[8]	A novel and efficient technique named Image Subtraction with Quantization of image is introduced which increases energy efficiency.	ISQ	The performance evaluation matrix is limited.
2008[9]	Aims to improve image transmission by introducing a new MAC protocol.	DCT EQ-MAC	Trade-offs between energy efficiency and quality.
2004[10]	Image conveyance across point-to-point, direct, wireless networks that achieves the end-to-end quality of service while consuming as little processing and transmission power as possible.	JPEG2000, Joint Source Channel Coding.	Incompatible with the multicast transmission.

PERFORMANCE ANALYSIS

"A bar graph has been created to show the relative energy consumption reduction for different works using various technologies, such as DWT, DCT, JPEG2000, and the EQ-MAC protocol, compared to existing technologies like BQ-MAC. The evaluation is based on related works."

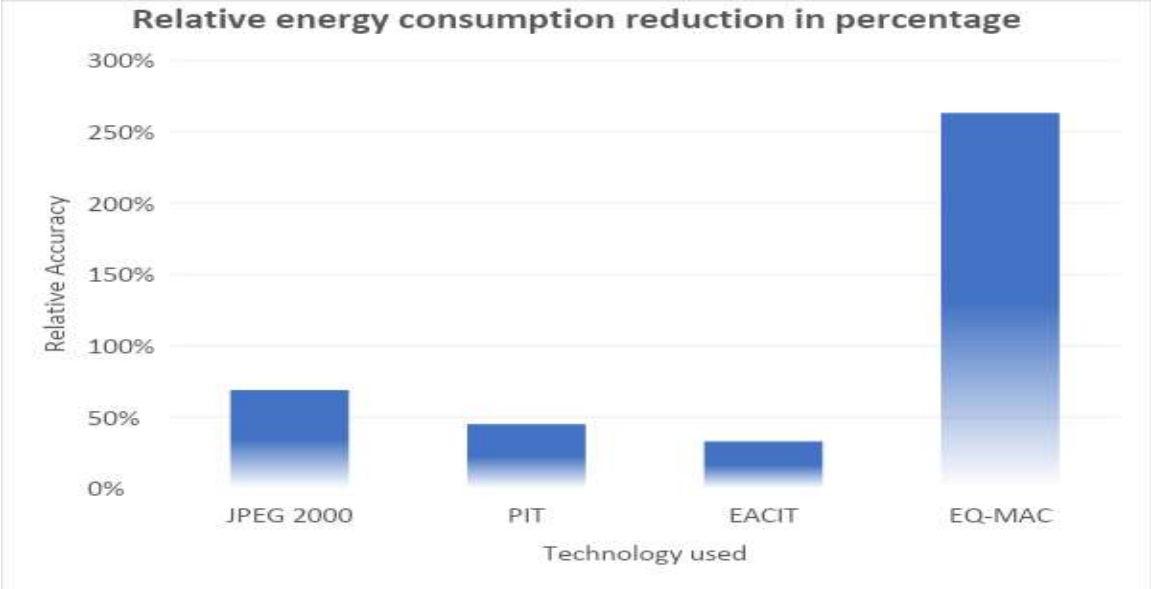

FIGURE 2. *Reduction in Energy Consumption of Different Technologies*

In [4], the average energy consumption reduction varies at different priority levels, but it has been found that it can reduce energy consumption by 69%, which maximizes the lifetime of the sensor nodes. Therefore, they can be utilized for longer periods and provide higher efficiency.

In [9], EQ-MAC is compared with the existing BQ-MAC. It has been found that EQ-MAC's efficiency is 263% higher than the latter one, which means that energy consumption differs significantly.

In [10], after using different coding channels, it has been found that the energy consumption has been reduced by 45%, which is the maximum value specified, and it subsequently enhances the system's efficiency.

Finally, in [1], the simulation results show that EACIT works better than current algorithms and can cut energy use by about 33%.

CONCLUSION

In this paper, we reviewed and compared best suited techniques that can make image transmission over WSN more efficient and secure. However, energy consumption and security threats remain significant challenges that must be addressed. While our analysis has shown that EACIT is the most promising technique for energy-effective and secure image conveyance over WSN, there is still room to fill the lacunae for further research. One potential avenue for future investigation is the development of more advanced security protocols that can better defend against sophisticated attacks, such as those involving advanced machine learning algorithms. Additionally, the integration of more intelligent routing algorithms could help to further reduce energy consumption, as well as improve network performance overall. Ultimately, however, we believe that the techniques we have reviewed represent a significant step in the field of WSN-based image transmission. We are going to create our system; our proposed system aims to

address the challenges of energy consumption and security threats in image transmission over WSN. To achieve this, we will be utilizing MATLAB and incorporating rudimentary concepts like APEC protocol. This will enable us to enhance security during image transmission and ensure energy efficiency. By implementing our system, we hope to improve the overall performance of WSN-based image transmission and provide a reliable and secure solution for various real-world applications. Moreover, our system can be easily customized and adapted to meet the requirements of different use cases.

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