

A Survey on Computer Graphics Technology with A Focus on Its Applications in Bio Medical Imaging

Dr.K. Arumugam^{1*}, Dr.S.Saravana kumar²

^{1,2}Assistant Professor, Department of Computer Science, Karpagam Academy of Higher Education, Coimbatore

Abstract

Humans are able to process visual information more quickly than any other kind of information. Recognition, monitoring, as well as surveillance are all made possible by image sensors. There are a wide range of applications where networks of sight sensors are the best answer. Designers of image sensor nodes face architectural problems, like processing power, energy consumption, communication routes, as well as sensing capabilities. In this article, we'll go through the features and specifications of an image sensor node. A wireless sensor network image sensor node is developed and built. CMOS sensor, RF module, image acquisition unit, and power unit are all included in the system. Imaging sensors may benefit from more energy-efficient hardware management solutions. In this article, the issue of picture compression in sensor nodes is thoroughly examined.

Keywords: Graphics Processing Unit (GPU), Image Segmentation, Image Registration, Image Visualization

1. INTRODUCTION

Sensor nodes in a wireless sensor network (WSN) are able to execute data processing as well as computations on the data they receive from other sensor nodes over a wireless communication channel. Habitat research, item tracking, environmental monitoring, satellite imaging, video surveillance, and military applications are all possible uses for WSNs.

* ISBN No. 978-81-955340-7-4

A Handbook On: Image Processing and Wireless Communication

There has recently been an increase in interest in developing a dependable as well as efficient wireless multimedia sensor network research and development study (WMSN). In a hardware restricted context, the development of a WMSN is problematic due to the substantial processing required for multimedia data like photos and video frames acquired from camera nodes. An efficient and versatile WMSN has several obstacles and limits, including high power consumption, restricted bandwidth, as well as memory limitations.

Since the development of MEMS (micro electro mechanical systems), sensor plus battery technology in recent years, it is now feasible to produce small sensor nodes that can perform several functions for a fraction of the cost and power normally required. Using wireless communication, a sensor network is formed by a large number of small sensor nodes. Traditional sensors have been significantly outperformed by sensor networks. An investigation of wireless sensor networks has been a major focus of industry and academic research. It's common for sensor nodes to include the following components: sensor(s), computer(s), radio(s), and power supply(s). In various types of situations, from disaster zones to battle zones to industrial plants and buildings, the sensor nodes are installed to detect important physical phenomena like temperature and humidity or to monitor interesting activities like moving objects, human movement, etc. Sensor nodes of various functionalities capture different types of data; for example, acoustic as well as image sensors may collect data on sound and sight. Networked sensors process and send acquired information to the base station.

2. LITERATURE REVIEW

(Yang & Chen, 2022) An investigation of the water resources system's complicated uncertainty is the focus of this paper. Water resources carrying capacity is separated into three subsystems: bearing pressure, bearing support capacity, and bearer control. This study introduces multi-dimensional conditional cloud algorithms and wireless sensor networks as analytical approaches to evaluate the carrying capacity of water resources such as correlation analysis and grey correlation analysis. Combine it with subtraction set opposition, the partial bias connection number, as well as the risk matrix. Three kinds of water resource carrying capacity assessment and trend analysis models were built, and they are all shown in the following tables. Carrying capacity estimates are consistent with actual process and show a steady upward trend in the overall development. Using the assessment model of the water resource carrying capacity, application results have been gathered. Using the extraction model's picture texture feature, we were able to get comparable results to what we saw before the modification. Change is becoming increasingly apparent. Water resource carrying capacity may be described as a whole, but it also characterises dependability of calculation findings and bearing risk due to uncertainty in water resource carrying systems. The water resources carrying capacity assessment as well as trend analysis of the calculation findings are realistic and attainable. Decision-making frameworks based on this study may be used to analyse and suggest adaptive risk prevention as well as control methods for the ability to carry out water resources-related activities in a systematic manner.

Dr. Algubelly Yashwanth Reddy and Dr. P. Hasitha Reddy

(Rodrigues et al., 2021) CG courses in a confined setting provide unique issues, methodology, and approaches, all of which we explore in this paper. We also evaluate our own experience and offer suggestions for future research. Our approach combines the complexity of CG subjects with the creation of relevant and engaging material for a CG course while addressing communication, support, and evaluation concerns. This is critical in the setting of a pandemic, because online courses may have a negative impact on students' involvement and contact with their teachers. Using an in-house WebGL-based instructional library called WebCGF, we were able to simplify onboarding while maintaining linkages to the underlying ideas and technologies using the methodology we've been using for the last several years. That paradigm has to be supplemented with collaboration tools and mentorship tactics because of the confinement restrictions. On top of remote lessons and video presentations, we also used tools for organised community involvement as well as Git-based code management systems particularly tailored for classroom usage. This enabled us to track the progress of each student's development process in more detail. Students' interest and performance were found to be on par with previous years, leading us to develop a set of criteria to keep in mind in similar situations.

(Fahad A. Rida, 2021) It was difficult to communicate with medical staff or patients because of bandwidth limits when medical technology, communication as well as computers were invented and used in the treatment as well as the follow-up of distant health care patients. Power consumption as well as sending large amounts of data between medical professionals and patients are strictly prohibited. Patients and physicians may exchange huge data, such as video and audio files, at any time and from any location thanks to CDMA-based wireless sensors, which employ a direct spread spectrum based on CDMA. The wireless sensor network uses binary transmission as well as multipath to reduce the power consumption of transmitter as well as receiver sensors. The measurement's precision is dependent on the device's bandwidth when estimating arrival time (TOA). TOA predictions are sent to the receiver simultaneously because of the MPC delay as well as reduced number of initial signal replication. Adding to the TOA's positive bias is the diffusion delay produced by the signal passing across obstacles.

(Morra et al., 2020) The development of powerful sports analytics as well as broadcasting software will benefit greatly from the development of the automatic event detection from photos or wearable sensors. Large-scale sport datasets are difficult to acquire and annotate because of technological challenges, data collecting costs, and economic interests. To generate synthetic data, we propose the Soccer Event Recognition (SoccER) data generator in this study, that is built on top of an already-existing, high quality open-source game engine. Spatio-temporal data and fine-grained, autonomously created event ground truth are generated by the programme. It also features an event detection system that was created as well as tested on a synthetic dataset that included 500 minutes of play and over 1 million events. As a last section, we propose potential directions for future work in the sports event identification, now that synthetic data has been introduced.

(Zamri & Sunar, 2020) One of the most important components of the natural phenomena visualisation system is the modelling of atmospheric clouds. In the past, a variety of ways have been presented to address the complex difficulties related with visual realism as well as performance. However, the scarcity

A Handbook On: Image Processing and Wireless Communication

of new review articles on computer graphics approaches for atmospheric cloud modelling makes it difficult for academics and practitioners to comprehend and choose the best options for constructing an atmospheric cloud visualisation system. A full study of the available atmospheric cloud modelling systems was thus done. The research trends on this issue were examined using 113 research papers from well-known data sources. By classifying the cloud modelling approaches according to their common properties, we created a taxonomy and summarised each method. Finally, we highlighted a number of research questions and possible avenues for further study. For both scholars and practitioners, this paper provides an overview as well as general picture of the atmospheric cloud modelling approaches.

(Martinez et al., 2019) In structural biology, one of the most frequent jobs is to visualise molecular structures using tools like Chimera, PyMOL, COOT or VMD. Computer graphics as well as data visualisation have had a significant impact on our knowledge of biomolecular function, and so this Perspective piece summarises current discoveries which promise to revolutionise structural biology. There has been a lack of contact between the computer scientists and structural as well as computational biologists who may benefit from these advancements in molecular graphics. We want to promote communication across these groups by referring to classic articles and describing the technological advancements underpinning new graphical breakthroughs in simple words. This, in turn, will help define the future of molecular graphics. Martinez et al. describe how computer graphics as well as data visualisation have helped to enhance our knowledge of biomolecular function, including review current breakthroughs in computer graphics which promise to revolutionise the structural biology.

(Hänel et al., 2019) With the use of hyperspectral imaging, geo-information may be collected in a variety of ways. Hyperspectral cameras on aircraft and satellites are now the primary competitors in large-scale imaging efforts. Aside from the fact that satellites and aircraft only fly over certain locations sporadically, long-term, continuous surveillance of certain regions is difficult to do with these methods. WSN-based ground monitoring is a prospective innovation that can be permanently installed and provides data more continually. Most wireless sensor networks (WSNs) don't employ hyperspectral sensors since they're too pricey and power-hungry. For a lower cost, we propose combining multispectral sensors, which may provide spectral resolution comparable to that of hyperspectral sensors while maintaining the WSN's inherent sensitivity to small changes in temperature and light. Using in situ and distant sensing datasets, we test our strategy by comparing several data processing techniques.

(Shaheen et al., 2019) Different areas, including as medicine, the military, the online personal albums, private communications, including video conferencing, all need the ability to store and send photos in a way that maintains their confidentiality. It is possible to encrypt images using a variety of methods. More data, more redundancy, plus the correlation between picture pixels distinguish digital images from text data. Wireless sensor networks (WSN) are being developed with a wide variety of encryption methods in mind. Because sensor nodes have limited memory, energy, and computing power, any new methods must take this into account. Traditional cryptosystems can't be used on WSNs since they don't work with digital pictures because of their structure and size. Discrete cosine transform (DCT) and discrete wavelet transform (DWT) are utilised in this work to offer digital pictures encryption methods for WSNs.

Dr. Algubelly Yashwanth Reddy and Dr. P. Hasitha Reddy

(Kin et al., 2017) Advances in the computer technology are allowing surgeons to plan and perform surgeries using a virtual reality model. A literature search was done to identify trends in virtual surgical simulations for brain tumours. MEDLINE yielded 1,298 results for the search term "neurosurgery AND (simulation OR virtual reality)". 28 papers on clinical application remained after excluding research for educational or training reasons. Clinical simulation needs to solve a few challenges, as seen by the overwhelming number of studies focused on teaching and training rather than actual surgery. There were also ten articles from Japanese organisations in the total of 28. Virtual surgical simulation has been shown to improve patient outcomes in 28 studies. Simulating intricate spatial relationships of anatomical landmarks as well as evaluating surgical techniques proved extremely helpful. A surgical navigation system or an augmented reality system, which displays virtual reality pictures onto the operating field, were employed in several investigations. It was found that the simulation systems were lacking the capacity to react to tissue deformation as a result of surgical operations, as well as the ability to reflect properties of tissue (such as hardness and adhesiveness). More information on image processing is needed, as seen by the paucity of details, which suggests that more work must be done before the technology can be used clinically to its fullest potential.

(Jarabo et al., 2017) When it comes to computer graphics as well as computer vision, transient imaging has lately had a massive influence. New approaches for recording, recreating, or simulating light transport have been suggested to display movies of light in motion, identify objects in highly-scattering surfaces, or infer material qualities from a distance, among other things. At the nanosecond or picosecond level, we may take use of a variety of information that is often lost during capture-time temporal integration. From a graphics as well as vision standpoint, this article highlights current improvements in transient imaging, covering capture methodologies, analysis, applications, as well as modelling of the results.

(Nisha & Megala, 2015) Sensors that communicate wirelessly Automated irrigation system for agricultural usage based on a network. Soil moisture as well as temperature sensors are embedded in a wireless sensor network to create the system. Irrigation system microcontrollers employ an algorithm based on sensor threshold values to manage water amount utilising the Zigbee protocol to handle sensor data. For data examination, the device is powered by solar panels and a cellular-internet interface. An image processing technology is used to keep track of the disease area by mounting a wireless camera in a crop field. Useful in locations where water is scarce and geographical isolation is a problem, the technology is low-cost and energy-independent.

(Hasan et al., 2014) In visual sensor networks, sensors with several dimensions, such as those used in digital cameras, are common. When compared to the scalar sensors in wireless sensor networks, VSNs produce enormous amounts of data. WSNs The limited processing as well as bandwidth requirements of low power sensor nodes make it difficult to process and send this kind of data in a hardware constrained environment. Vision data acquired by sensor nodes may be reduced in size before being sent to its final destination by using source coding. By reducing unnecessary data from the collected picture raw data, image compression provides a more efficient processing and transmission mechanism. JPEG and JPEG2000 are only a few examples of the many kinds of conventional, state-of-the-art image

A Handbook On: Image Processing and Wireless Communication

compression standards discussed in this study. A literature assessment of the benefits and drawbacks of using these algorithms in the VSN hardware environment is provided here. Compression methods for VSNs are also described, along with their key influences. Some hardware-oriented qualities of the chosen compression technique include simplicity in coding, low memory requirements, low computational burden, and a high compression rate." The severe hardware limits in WSNs are addressed head-on in this survey work, which calls for a hardware-based image compression method that consumes less energy.

(Lloret et al., 2011) Observing the stems, the grapes, and/or the leaves of a vineyard is first step in identifying any deficiencies, pests, or diseases that may be present. It's clearly not cost- or deployment-effective to put a sensor in each vine in each vineyard. We need to explore for innovative ways to accurately and affordably identify these signs. Sensor nodes in this network collect photographs of the field as well as analyse the images internally to identify any abnormalities in the leaves, as shown in this study. In addition to a deficit or pest, this condition might be caused by illness or another damaging substance. When an issue is discovered, a message is sent from the sensor node to sink node over the wireless sensor network, alerting the farmer. The IEEE 802.11 a/b/g/n standard is used by the wireless sensor, allowing communications over long distances in open air. Wireless sensor network architecture, wireless sensor placement, node image processing, as well as sensor network traffic from a flat vineyard in Spain are described in this study. For example, a symptoms database as well as an integrated neural system might be included for a more accurate issue diagnosis despite the system's inability to discriminate between deficiency, pest, illness, or other hazardous substances.

(Pingping et al., 2009) An unmanaged and potentially hostile environment is the setting for the transmission of digital picture data in a wireless sensor network (WSN). In order to safeguard the wireless sensing data creators' interests, copyright protection has received a great deal of attention. As a result of the additional overhead, traditional security measures are computationally inefficient. Watermark systems are often low in weight as well as do not need a large amount of computation or power resources. In this way, wireless sensor applications may find them to be enticing alternatives. This study provides a real-time, resilient watermark technique based on the DCT coefficients, which are derived by experimentation. As a result, the watermark has been embedded within the DCT's low-frequency coefficients to increase its robustness. The results of the experiments reveal that this technique is real-time, undetectable, as well as robust enough to meet wireless network transmission criteria.

(Li et al., 2008) Humans are able to process visual information more quickly than any other kind of information. Recognition, monitoring, as well as surveillance are all made possible by image sensors. There are a wide range of applications where networks of sight sensors are the best answer. Designers of image sensor nodes face architectural problems, like processing power, energy sources, energy consumption, communication routes, as well as sensing capabilities. In this article, we'll go through the features and specifications of an image sensor node. A wireless sensor network image sensor node is developed and built. CMOS sensor, RF module, image acquisition unit, and power unit are all included in the system. Imaging sensors may benefit from more energy-efficient hardware management solutions. In this article, the issue of picture compression in sensor nodes is thoroughly examined.

Dr. Algubelly Yashwanth Reddy and Dr. P. Hasitha Reddy

(Bilotta et al., 2006) In order to share our findings with others working in the field of computer graphics, we've written this article to share some of the challenges we've encountered while trying to visualise patterns from Chua's circuit. Furthermore, the study discusses cutting-edge computer graphics approaches for portraying chaotic as well as hyperchaotic systems while yet maintaining control of complexity. Since the output might be formed of diverse pieces such as cubes, cylinders, and so on, we've had issues with the nature of such configurations, their forms and dimensions, as well as the granularity of these things. There are still many unanswered questions about how we see 3D shapes and recognise them.

3. APPLICATIONS

Sensor networks may be used in a variety of industries, including military, healthcare and the home. Humans are able to process visual information more quickly than any other kind of information. Recognition, monitoring, and surveillance are all made possible by image sensors. There are a wide range of applications where networks of sight sensors are the best answer.

- **Surveillance:**

Mechanisms for detecting as well as tracking intruders across broad regions are required for the protection of major installations (airports, factories, stadiums). Visual processing may be used to identify and evaluate events, and visual information of interest can be relayed to the base station using miniature image sensors.

- **Environmental monitoring:**

Many scenarios need for long-term visual monitoring of large, inaccessible regions in order to discover anomalies or collect environmental data. Traffic management on motorways as well as in natural habitats like woods and deserts are examples of hazardous places. NASA's Jet Propulsion Laboratory (JPL) created Sensor Webs a few years ago to detect the Martian surface.

- **Military reconnaissance:**

Image sensors collect high-quality pictures in order to enhance the command state's perceptibility, properly estimate the threat, and follow it. For the purpose of improving army combat and command capabilities, several nations have conducted military scientific research on image sensor networks. A medical assistant who assists with medical procedures Doctors can keep an eye on their patients' health thanks to built-in image sensor nodes. Surgeons may benefit from the use of image sensors during an operation. For instance, image sensors let surgeons do thoracic mirror surgery using a television as a mirror. In addition, several image sensor nodes are used to monitor the operation's progress, which is then evaluated by medical professionals.

A Handbook On: Image Processing and Wireless Communication

Wireless sensor networks' most essential design aim is to extend the network's lifespan because of the restricted power supply. For image sensor nodes, greater processing power, more energy, as well as a larger bandwidth are required. The image sensor node presents a number of architectural issues for designers, including processing power, energy consumption, energy sources, communication routes, and sensors. At same time, the base station receives a vast amount of data created by the device. To tackle the issue of limited energy as well as bandwidth, the energy-efficient picture transmission as well as network protocols are needed.

4. CHARACTERISTICS AND REQUIREMENTS

Our focus here is on image sensor node features and needs.

1. Higher processing power and more memory

Due to the large amount of information in a picture, image capture and processing are computationally as well as memory-intensive operations.. Bayer pattern images with 8-bit pixels use 300KB of RAM for a 640x480 resolution picture. After interpolation, an RGB mode picture uses 900KB of memory. The green component of a colour image's histogram calculation necessitates an arithmetic comparison of 300KX256. Image compression is required to lower the amount of memory used. Image compression, on the other hand, is a more computationally demanding process.

2. Real-time and high communication bandwidth

For an image sensor network, real-time is a need. The image sensor node, for instance, must capture an image as soon as an intruder enters the monitoring area, analyse it quickly, and communicate it. Consequently, high-speed picture capture and processing are necessary. High bandwidth is required because of the massive volume of picture data. However, the transmission bandwidth of the image sensor node is restricted. Image compression as well as partial image processing must be implemented at the node in order to avoid the demand for high connection bandwidth. The base station only receives data that is absolutely essential, thanks to basic picture analysis.

3. Energy-efficient

Because every image sensor node is powered by a single battery, low power design should be addressed.. It is more energy-intensive to transmit images than it is to compute. There must be an energy-efficient method of transmitting images. Multi-hop Wireless Sensor Network (WSN) makes it difficult to send data from sensor node to the base station directly. Using an energy-efficient network routing strategy may extend the life of the network by preventing the depletion of the nodes on a particular route.

4. Robust transmission and quality of service (QoS)

Wireless channels are susceptible to noise, which may cause transmission failures. To remedy the issue, robust transmission methods are required. With FEC and ARQ, the most common resilient

techniques, errors may be coded and retransmitted automatically. Take a look at this scenario: Identifying a target in a combat situation is critical. Imaging sensors should be used to locate a potential prey item. These sensors may be activated to identify and track the target after it has been located and detected. For this to work, sensors and controllers need to transmit data in real time. To handle real-time multimedia data, you need a particular amount of bandwidth and the smallest amount of delay and jitter that you can get away with. QoS traffic has to be reliably delivered through a service differentiation mechanism.

5. Distributed processing and collaboration

Images are captured by each individual sensor node. Image sensor nodes may have overlapping fields of vision as a result of fault consideration or dense deployment. To cut down on the needless, collaborative processing is required. Neighbor image sensor nodes communicate with each other to perform object tracking tasks. It is also possible for image sensor nodes to work with other types of nodes in order to perform a job more effectively. Low cost and compact size are other important considerations for image sensor nodes in addition to the previously mentioned traits and criteria.

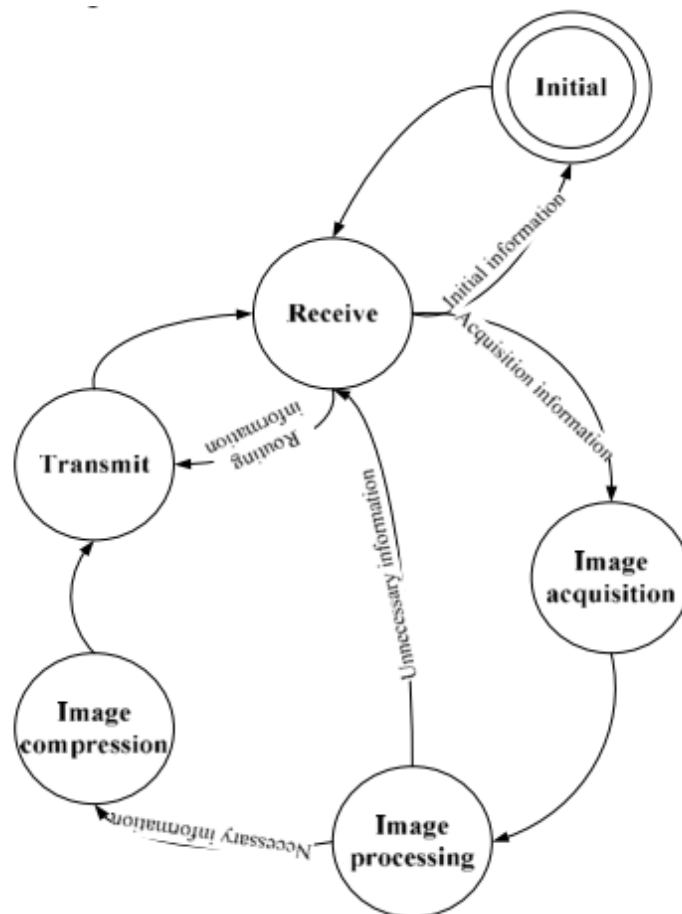


Figure 26 State transition state graph of image sensor node

5. GRAPHICS IMAGE COMPRESSION

The image sensor nodes have an important role to play in compressing images. Hardware or software may be used to compress images. Low-power hardware implementation requires a lengthy design cycle. The embedded processor provides significant levels of freedom for software implementation. Real-time as well as low power requirements, on the other hand, remain unmet. For image sensor nodes, hardware implementation is the best option in the long run.

An image compression technique known as DWT (Discrete Wavelet Transform) has been employed in a wide range of applications. Its computing strength, however, seems to be the major constraint. It has been shown that the calculation of DWT may be lowered by a factor of two. The combined advantages of the Integer Wavelet Transform (IWT) and the use of filters with integer lifting coefficients may be used to produce still further improvement. In instance, the LeGall filter, that is used by default in JPEG2000 for lossless compression, has excellent de-correlation performance despite its simplicity. Although its performance is somewhat lower than CDF's, it is an excellent option for low-energy systems because of its reduced processing needs. In order to test a wireless sensor network with reconfigurable IWT IP, a CPLD-implemented version was developed. According to the data, current CPLDs are capable of achieving very impressive low-energy performance. Additionally, we use the lift strategy based LeGall wavelet transform in the image sensor nodes as well as implement it in the FPGA. A huge quantity of redundant background information is acquired due to the static nature of the image sensor nodes. Shape-Adaptive Discrete Wavelet Transforms (SADWT) may be utilised to further minimise the amount of data sent. When there are no objects in the field of view, image sensor nodes may capture a backdrop picture. To get an input mask picture in the Image Processing Module, you compare the background image to the collected image. In terms of data reduction, this approach beats ROI coding. The wavelet area compression technique may be used to further process wavelet coefficients.

The various benefits of wavelet transform-based embedded image coding, such as resolution scaling, quality scalability, and rapid codec speed, have led to its widespread use. Coded embedded images are used for two purposes: 1) taking use of the highest picture quality possible at a given bit rate, 2) In other words, all images encoded at lower bit rates are placed at the beginning of bit stream for the desired bit rate, rather than being tacked on at the end.

Two issues need to be addressed by the embedded coding method: First, how to classify as well as code the wavelet coefficients according to their relative significance, and then how to include the code stream's positional information about the most significant coefficients. The bit planes coding approach may be used to address problem number two. Options for resolving the issue Structure-based as well as context-based coding are the two primary catalogues. There are a variety of structures-based coding techniques, the most common of which being embedded zerotree wavelets, set partitioning in hierarchical trees, and set partitioning embedded blocks, amongst others. EBCOT, pixel classification and sorting (PCAS), morphological representation of wavelet data (MRWD) are examples of context-based coding techniques.

With regard to classification of wavelet coefficients as well as arithmetic coding, context-based approaches are more efficient than the structure-based methods. For image sensor nodes, the complicated algorithms can't be tailored to the low power needs. Table 1 contains a comparison of performance metrics for your perusal.

Table 2 Comparison of lossy coding methods for three common test images

Coding method	PSNR(dB)		
	0.25bpp	0.5bpp	1.0bpp
Lena image ($512 \times 512 \times 8\text{bpp}$)			
EZW	33.17	36.28	39.55
SPIHT	34.11	37.21	40.44
SPECK	34.03	37.10	40.25
Barbara image ($512 \times 512 \times 8\text{bpp}$)			
EZW	26.77	30.53	35.14
SPIHT	27.58	31.40	36.41
SPECK	27.76	31.54	36.49
Goldhill image ($512 \times 512 \times 8\text{bpp}$)			
EZW	30.31	32.87	36.20
SPIHT	30.56	33.13	36.55
SPECK	30.50	33.03	36.36

SPIHT as well as SPECK outperform EZW, as can be shown in Table 1. It's less effective than SPIHT for Lena & Goldhill, but more effective than SPIHT for Barbara. Wavelet pyramid decomposition sub-band correlation is used by SPIHT, whereas sub-band energy convergence is used by SPECK. This means that the SPIHT has to deal with a lot of memory access issues while sorting coefficients in a spatial orient tree. This means that SPIHT is not resolution scalable as well as has a lower resilience to Bit Error Rate than other coding techniques (BER).

SPECK's key benefits are as follows.

1) Progressive transmission: The information content of the source samples is coded in decreasing order.

2) Low computational complexity: There are no sophisticated computations required in the method, which consists mostly of comparisons.

3) Low dynamic memory requirements: Only one linked area (e.g., a 32×32 block sitting entirely inside a sub-band) is handled at a time throughout the coding process.

4) Fast encoding/decoding: Due to its simplicity and the fact that it can operate with data that fits entirely in the CPU's quick cache memory, this technique uses less data from slower storage. If you're looking for low-power image compression methods for the image sensor nodes, SPECK is your best bet.

6. CONCLUSION

A brief introduction to wireless network based digital image processing as well as its IOT applications in many domains, with an emphasis on image compression methods, is provided as part of our article in order to be self-sufficient. Using lifting wavelet transform-based image compression, this work presents a low-memory as well as low-complexity version of SPIHT that does not need entropy coding. By making modest tweaks to SPIHT software, this technique greatly decreases memory needs while maintaining all the benefits of embedded programming attained with strip-based, listless coder as well as line-based SPIHT.

Performance in a hardware environment isn't much harmed because of the smaller memory as well as circuitry. This energy-efficient picture compression technique is thus closer to implementation in highly restricted hardware contexts, like VSNs, due to the decrease in DWT coding complexity and the huge reduction in memory required. An image-integrated FPGA and ASIC circuits may be used to test the performance of the hardware-based image compression technique. This would result in considerable energy savings as well as processing time reductions.

REFERENCES

- Bilotta, E., Pantano, P., & Stranges, F. (2006). Computer graphics meets chaos and hyperchaos. Some key problems. *Computers and Graphics (Pergamon)*, 30(3), 359–367. <https://doi.org/10.1016/j.cag.2006.02.003>
- Fahad A. Rida, J. (2021). Development of a remote health care wireless sensor network based on wireless spread spectrum communication networks. *Materials Today: Proceedings*, xxxx. <https://doi.org/10.1016/j.matpr.2021.02.534>
- Hänel, T., Jarmer, T., & Aschenbruck, N. (2019). Using distributed compressed sensing to derive continuous hyperspectral imaging from a wireless sensor network. *Computers and Electronics in Agriculture*, 166(May), 104974. <https://doi.org/10.1016/j.compag.2019.104974>
- Hasan, K. K., Ngah, U. K., & Salleh, M. F. M. (2014). Efficient hardware-based image compression schemes for wireless sensor networks: A survey. *Wireless Personal Communications*, 77(2), 1415–1436. <https://doi.org/10.1007/s11277-013-1588-8>
- Jarabo, A., Masia, B., Marco, J., & Gutierrez, D. (2017). Recent advances in transient imaging: A computer graphics and vision perspective. *Visual Informatics*, 1(1), 65–79. <https://doi.org/10.1016/j.visinf.2017.01.008>
- Kin, T., Nakatomi, H., Shono, N., Nomura, S., Saito, T., Oyama, H., & Saito, N. (2017). Neurosurgical virtual reality simulation for brain tumor using high-definition computer graphics: A review of the literature. *Neurologia Medico-Chirurgica*, 57(10), 513–520. <https://doi.org/10.2176/nmc.ra.2016-0320>

Dr. Algubelly Yashwanth Reddy and Dr. P. Hasitha Reddy

Li, W. C., Ang, L. M., & Kah, P. S. (2008). Survey of image compression algorithms in wireless sensor networks. *Proceedings - International Symposium on Information Technology 2008, ITSIM*, 3. <https://doi.org/10.1109/ITSIM.2008.4631875>

Lloret, J., Bosch, I., Sendra, S., & Serrano, A. (2011). A wireless sensor network for vineyard monitoring that uses image processing. *Sensors*, 11(6), 6165–6196. <https://doi.org/10.3390/s110606165>

Martinez, X., Krone, M., Alharbi, N., Rose, A. S., Laramée, R. S., O'Donoghue, S., Baaden, M., & Chavent, M. (2019). Molecular Graphics: Bridging Structural Biologists and Computer Scientists. *Structure*, 27(11), 1617–1623. <https://doi.org/10.1016/j.str.2019.09.001>

Morra, L., Manigrasso, F., & Lamberti, F. (2020). SoccER: Computer graphics meets sports analytics for soccer event recognition. *SoftwareX*, 12, 100612. <https://doi.org/10.1016/j.softx.2020.100612>

Nisha, G., & Megala, J. (2015). Wireless sensor Network based automated irrigation and crop field monitoring system. *6th International Conference on Advanced Computing, ICoAC 2014*, 189–194. <https://doi.org/10.1109/ICoAC.2014.7229707>

Pingping, Y., Suying, Y., Jiangtao, X., Yu, Z., & Ye, C. (2009). Copyright protection for digital image in wireless sensor network. *Proceedings - 5th International Conference on Wireless Communications, Networking and Mobile Computing, WiCOM 2009*. <https://doi.org/10.1109/WICOM.2009.5305347>

Rodrigues, R., Matos, T., Valle de Carvalho, A., Barbosa, J. G., Assaf, R., Nóbrega, R., Coelho, A., & de Sousa, A. A. (2021). Computer Graphics teaching challenges: Guidelines for balancing depth, complexity and mentoring in a confinement context. *Graphics and Visual Computing*, 4, 200021. <https://doi.org/10.1016/j.gvc.2021.200021>

Shaheen, A. M., Sheltami, T. R., Al-Kharoubi, T. M., & Shakshuki, E. (2019). Digital image encryption techniques for wireless sensor networks using image transformation methods: DCT and DWT. *Journal of Ambient Intelligence and Humanized Computing*, 10(12), 4733–4750. <https://doi.org/10.1007/s12652-018-0850-z>

Yang, Y., & Chen, J. (2022). Comprehensive analysis of water carrying capacity based on wireless sensor network and image texture of feature extraction. *Alexandria Engineering Journal*, 61(4), 2877–2886. <https://doi.org/10.1016/j.aej.2021.08.018>

Zamri, M. N., & Sunar, M. S. (2020). Atmospheric cloud modeling methods in computer graphics: A review, trends, taxonomy, and future directions. *Journal of King Saud University - Computer and Information Sciences*, xxxx. <https://doi.org/10.1016/j.jksuci.2020.11.030>