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ABSTRACT

In order to make data storage more effective and to use up less storage space, data can be compressed. Additionally, data compression helps speed up the transmission of data exchange. Currently, a variety of techniques can be employed to data compression. Moreover, the outcomes and approaches of each treatment vary. The comparison of data compression will be covered in this essay. We present a detailed analysis of Five separate algorithms, Shannon-Fano, Run-Length Encoding, the Huffman Algorithm, the LZW Algorithm, and the DELTA Algorithm. To address these issues, there is a growing need for greater data compression and communication theory research. Such study addresses the needs of fast data transfer through networks. This study focuses on deep learning analysis of the most widely used picture compression methods.

REFERENCES

- [1] Fabian Mentzer, Eirikur Agustsson, Michael Tschannen, Radu Timofte, and Luc Van Gool. Practical full resolution learned lossless image compression. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pages 10629–10638, 2019.
- [2] Chris Solomon and Toby Breckon. Fundamentals of Digital Image Processing: A practical approach with examples in Matlab. John Wiley & Sons, 2011.
- [3] Kenta Kurihara, Shoko Imaizumi, Sayaka Shiota, and Hitoshi Kiya. An encryption-then-compression system for lossless image compression standards. IEICE transactions on information and systems, 100(1):52–56, 2017. Publisher: The Institute of Electronics, Information and Communication Engineers.
- [4] M. D. Manigandan and S. Deepa. Comprehensive study on the effect of entropy encoding algorithms on medical image compression. International Research Journal of Engineering and Technology, 5(4):3460–3468, 2018.
- [5] Mohamed Uvaze Ahamed Ayoobkhan, Eswaran Chikkannan, Kannan Ramakrishnan, and Saravana Balaji Balasubramanian. Prediction-based Lossless Image Compression. In International Conference on ISMAC in Computational Vision and Bio-Engineering, pages 1749–1761. Springer, 2018.
- [6] James Townsend, Thomas Bird, Julius Kunze, and David Barber. HiLLoC: Lossless Image Compression with Hierarchical Latent Variable Models. arXiv preprint arXiv:1912.09953, 2019.
- [7] Karam [Lina J. Chapter 16 - Lossless Image Compression. In Al Bovik, editor, The Essential Guide to Image Processing, pages 385 – 419. Academic Press, Boston, 2009.

- [8] Bin Xiao, Gang Lu, Yanhong Zhang, Weisheng Li, and Guoyin Wang. Lossless image compression based on integer Discrete Tchebichef Transform. *Neurocomputing*, 214:587–593, 2016. Publisher: Elsevier.
- [9] Bogdan Rusyn, Oleksiy Lutsyk, Yuriy Lysak, Adolf Lukenyuk, and Lubomyk Pohreliuk. Lossless image compression in the remote sensing applications. 37 References 38 In 2016 IEEE First International Conference on Data Stream Mining & Processing (DSMP), pages 195–198. IEEE, 2016.
- [10] N. Muthukumaran and R. Ravi. Hardware implementation of architecture techniques for fast efficient lossless image compression system. *Wireless Personal Communications*, 90(3):1291–1315, 2016. Publisher: Springer.
- [11] Med Karim Abdmouleh, Atef Masmoudi, and Med Salim Bouhlel. A new method which combines arithmetic coding with rle for Lossless image compression. 2012. Publisher: Scientific Research Publishing.
- [12] S. W. Chiang and L. M. Po. Adaptive lossy LZW algorithm for palettised image compression. *Electronics Letters*, 33(10):852–854, 1997. Publisher: IET.
- [13] Paul G. Howard and Jeffrey Scott Vitter. Parallel lossless image compression using Huffman and arithmetic coding. In *Data Compression Conference*, 1992., pages 299–308. IEEE, 1992.
- [14] Rafeeq Al-Hashemi, Ayman Al-Dmour, Fares Fraij, and Ahmed Musa. A Grayscale Semi-Lossless Image Compression Technique Using RLE. *Journal of Applied Computer Science & Mathematics*, (10), 2011.
- [15] Takashi Nishitsuji, Tomoyoshi Shimobaba, Takashi Kakue, and Tomoyoshi Ito. Fast calculation of computer-generated hologram using run-length encoding based recurrence relation. *Optics express*, 23(8):9852–9857, 2015. Publisher: Optical Society of America.
- [16] Awwal Mohammed Rufai, Gholamreza Anbarjafari, and Hasan Demirel. Lossy medical image compression using Huffman coding and singular value decomposition. In

2013 21st Signal Processing and Communications Applications Conference (SIU), pages 1–4. IEEE, 2013.

[17] Vipul Sharan, Naveen Keshari, and Tanay Mondal. Biomedical image denoising and compression in wavelet using MATLAB. *International Journal of Innovative Science and Modern Engineering (IJISME)* ISSN, pages 2319– 6386, 2014. Publisher: Citeseer.

[18] Chaladze G. Kalatozishvili. Linnaeus 5 Dataset for Machine Learning <http://chaladze.com/15/>, 2017.

[19] Mamta Sharma. Compression using Huffman coding. *IJCSNS International Journal of Computer Science and Network Security*, 10(5):133–141, 2010.

[20] Rachit Patel, Virendra Kumar, Vaibhav Tyagi, and Vishal Asthana. A fast and improved Image Compression technique using Huffman coding. In 2016 References 39 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), pages 2283–2286. IEEE, 2016.

[21] A. Alarabeyyat, S. Al-Hashemi, T. Khmour, M. Hjouj Btoush, S. BaniAhmad, R. Al-Hashemi, and S. Bani-Ahmad. Lossless image compression technique using combination methods. *Journal of Software Engineering and Applications*, 5(10):752, 2012. Publisher: Scientific Research Publishing.

[22] Hassan K. Albahadily, V. Yu Tsviatkou, and V. K. Kanapelka. Grayscale image compression using bit plane slicing and developed RLE algorithms. *Int. J. Adv. Res. Comput. Commun. Eng.*, 6:309–314, 2017.

[23] Amit Birajdar, Harsh Agarwal, Manan Bolia, and Vedang Gupte. Image Compression using Run Length Encoding and its Optimisation. In 2019 Global Conference for Advancement in Technology (GCAT), pages 1–6. IEEE, 2019.

[24] Nageswara Rao Thota and Srinivasa Kumar Devireddy. Image Compression Using Discrete Cosine Transform. page 9.

[25] Andrew B. Watson. Image compression using the discrete cosine transform. *Mathematica journal*, 4(1):81, 1994. Publisher: Redwood City, Ca.: Advanced Book Program, Addison-Wesley Pub. Co., c1990-.

[26] Prabhakar Telagarapu, V. Jagan Naveen, A. Lakshmi Prasanthi, and G. Vijaya Santhi. Image compression using DCT and wavelet transformations. *International Journal of Signal Processing, Image Processing and Pattern Recognition*, 4(3):61–74, 2011.

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List of abbreviations

1. LZW: Lempel-Ziv-Weich.
2. RLE: Run Length Encoding.
3. MSG: Meteosat Second Generation.
4. SEVIRI: Spinning Enhanced Visible and Infrared Imager.
5. IR: Infrared.
6. ACL: Average code length.
7. CR: Compression ratio.
8. ET: Encoding time.
9. DT: Decoding time.

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