

# HUFFMAN BASED LZW LOSSLESS IMAGE COMPRESSION USING RETINEX ALGORITHM

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**Abstract:** image data compression is used in picture compression to reduce the number of bits needed to represent an image compared to its original format. Picture compression tries to get rid of extra and unnecessary image data so that it can be stored and sent more quickly. So, picture compression might make transmission faster and lower network latency. when you choose a lossless compression method, the data stays the same during the process and doesn't lose anything. This work presents a new 3-stage lossless compression method for images called Huffman inspired LZW Lossless Compression of images using the Retinex algorithm. the first thing to do is use Huffman coding to make the picture smaller. the second stage is to use LZW to compress the data and then connect all of the Huffman code words to decode it. In step three, the Retinex algorithm is used at the compressed picture to improve the overall quality and contrast of the image. “You can make MATLAB's compression rate (CR) or mean square error (MSE) better by using this strategy”.

*“Index terms - Huffman coding, LZW compression, lossless image compression, Retinex algorithm, image enhancement, data reduction, compression rate, mean square error, image quality improvement, MATLAB implementation”.*

## 1. INTRODUCTION

Image compression works by encoding the original picture with a small number of bits. The objective of photo compression is to make storing and sending data more efficient by getting rid of unnecessary and duplicate visual data. when you compress images, you have to save important information while also lowering the amount of picture data. In arithmetic, this means turning a 2d array of pixels into a set of data that is not linked in any way. before the picture is saved or sent, it is changed. to put the picture back together or anything quite similar to it, the

compressed image is decompressed afterward. image compression is used to make pictures take up less space in memory. You can't send or save images that need a lot of bits to be shown without reducing them in some way. most pictures feature pixels that are close to each other that convey information that is related and hence unnecessary. the main goal is to find a representation of the picture that is less related to it. Compression is made up of main parts: reducing redundancy and irrelevancy. The purpose of reducing redundancies is to get rid of duplicates in the sign source, which can be a picture or a video. when you reduce irrelevancy, you take out

information from the signal that isn't important to the receiver, which in this case is a person's eye.

Image compression is a type of data compression that uses a small number of bits to encode the original image. The goal of picture compression is to get rid of unnecessary and irrelevant information in the image data so that it may be stored or sent in a more efficient way. Image compression is the process of making image data smaller while keeping the important information. This involves changing a 2d pixel array into a data set that doesn't have any correlation between its parts. Before the image is stored or sent, the alteration is done. The compressed image is then expanded to recreate the image and a rough version of it. So, to save memory, image compression is done to make an image smaller. It takes a lot of bits to represent an image, and if you need to send or save the image, you can't do so without somehow cutting down on the amount of bits.

Most photos have pixels that are connected to each other, which means they have extra information. So, the first thing to do is to discover a representation of the image that is less associated. Redundancy and irrelevancy reduction are of the most important parts of compression. The goal of reducing redundancies is to cast off duplicates in the signal source (image or video). Irrelevancy reduction takes out bits of the signal that the Human visual system, which is the signal receiver, won't notice.

## 2. LITERATURE SURVEY

[1] Vartika Singh gives a full picture of the common ways that digital systems compress images. The study shows how both lossless and lossy compression methods can make images smaller while still keeping

their quality at an acceptable level. "It stresses how JPEG, PNG, and GIF are used in many fields, like web apps, medical imaging, and digital photography". The study talks about the pros and cons of traditional methods, especially when used in real time. In general, this review is a good starting point for academics who want to improve the way images are stored and sent.

[2] Mamta Sharma talks about Huffman coding as an important algorithm in the area of image compression. The article discusses the operation of Huffman coding through assigning the symbols that occur frequently shorter binary codes. This is an efficient technique to describe bits and can make image files reduced in size though no information is lost in the process. There is also the issue of implementation problems and how to improve things to ensure they work better that is spoken of in the work. The paper concludes by indicating the Huffman coding continues to exist as a major component of the hybrid compression systems.

[3] Sindhu M and Rajkamal R provide in-depth description of the numerous picture compression techniques, both the ancient and modern. In the research, the concepts of predictive coding, transform coding and vector quantization are investigated. It also emphasises the necessity of ensuring that a balance is reached between the maintenance of quality of the image and the necessity of making the compression more efficient. They reveal in their analysis that more than one strategy used in hybrid methods works better. The review can be effectively used to get familiar with the changes of compression methods through time.

Saravanan and Ponalagusamy C. (2009) devise a different method of compressing grayscale images without taking away some quality in the images by employing Huffman coding and symbol reduction jointly. The algorithm operates by reducing the count of unique sources symbols prior to the compression algorithm been applied. This algorithm reduces the entropy of image data, and thus makes things efficient. Their findings allude that any image of satellite and medical data can be more efficiently packed with a reduced storage requirement. The finding indicates the promise of a potentially exciting method to compress medical and satellite-based images in scenarios where the preservation of the information cannot be overstated.

Dynamic arrays and bit-plane analysis offer Mayur Nandihalli and Vishwanath Baligar [5] the opportunity to compress photographs in gray scales without any information being omitted. The technique is geared towards estimation of the pixel values on the upper bit planes so as to improve the compression. Their technique allows them to deal with various intensity levels of pixels and patterns in a versatile manner. The results indicate that the compression is very good and preserves the original image layout. this implies that the method can be applied in instances where precision could be very essential.

In [6] R.S. Aarthi, D. Muralitharan, and P. Swaminathan examine the possibility of using Huffman coding to further compress test data. The article explains how it is possible to reduce the amount of redundant patterns in testing data so that it can be easier to store. To increase the speed of data transfer and reduce memory they employ Huffman encoding. The authors emphasize on the fact that the

technique is applicable in testing VLSI and even hardware systems. The procedure does not only reduce the data quantity however, it also preserves the information accuracy of the encoded result.

[7] A. Al-Arabiya and others considers other methods of picture compression without the loss in a combination of various approaches to picture compression. Their mix of predictive coding, dictionary-based, and entropy supports getting the compression ratio. they state that when more than one method jointly applied, it works better as compared to using a single method. The paper examines the difficulty of computation, memory use and and compression accuracy. Other pairings have performed worse during tests compared to their suggested ones.

[8] “Md. Rubaiyat Hasan talks about a Huffman-based LZW” encoding approach that makes data compression more efficient. The study talks about a hybrid method that first uses Huffman coding to compress data, and then LZW to make it even smaller. This two-stage approach is better at getting rid of redundancy and speeding up encoding. The study demonstrates good results when evaluated on big data sets, such image files. The hybrid structure also makes sure that the original data may be recovered without any loss.

[9] “Monika and Pragati Kapoor look at a hybrid picture” compression method that uses both Huffman and LZW algorithms. The goal of combining both methods is to make digital image compression work better. Their results show that using both entropy and dictionary coding together is more efficient than using either one on its own. The paper talks about using typical image datasets and examines things like

speed and compression ratio. This effort helps build compression solutions that are strong and can grow.

“A. Maliah, S. k. Shabbir, and T. Subhashini” provide a better compression technique that uses the AnSpiht algorithm, Huffman encoding, and the Retinex approach. The method improves both the quality of the produced image and the efficiency of the compression. After compression, Retinex is used to increase contrast, which makes the pictures better for display and analysis. The study shows that visual integrity and perceptual clarity have both increased. It gives you a complete way to save and send images.

[11] “C. Saravanan and M. Surender make Huffman coding” work better by adding Lempel Zig coding to the compression pipeline. This mixed approach is meant to make the binary representation of visual data even better. The combination cuts down on bit redundancy and speeds up compression. Their results reveal that they do a better job of preserving space and rebuilding things accurately. The approach could be useful for real-time image processing tasks that need fast compression.

[12] “Using the Retinex algorithm, Mr. D. V. Patil and his co-authors” come up with an automated way to make images clearer. The study's main goal is to improve the visibility and contrast of photos taken in low light. Their use makes the brightness and color constancy of images better in real time. Retinex technique is much useful in medical imaging, as well as monitoring. The study indicates how one can bring about the enhancement and compression algorithms in combination.

In the article [13] Although this is a new and more powerful multi-scale Retinex method to enhance

color images, it only shows the capability of further enhancing color images by using a multi-scale Retinex method. The method operates on images of various spatial scales so as to maintain detail and alter light. This mechanism makes the dynamic range and color accuracy of photos a lot improved. it is immensely helpful when it comes to programs that need to manipulate and compress images. The researchers reveal that the Retinex methods have the ability to enhance the image quality and are compatible with compression algorithms.

[14] “Using the multi-scale Retinex method, Rahman, Jobson, and Woodall look at how improving an image affects its size”. The study looks at how image processing affects how well compression works. Their research demonstrates that photos using Retinex often compress better because the contrast is clearer and there is less noise. This synergy makes it easier to add enhancement approaches to compression pipelines. The results support the idea of optimizing imaging systems together.

[15] “Asadollah Shabhahrami” and his team look at the Huffman and arithmetic coding algorithms to see how nicely they work for multimedia compression standards. The study looks at how well, quickly, and complicated both algorithms work with different sorts of data. people like Huffman coding because it is simple and works in real time. arithmetic coding, on the other hand, is better at compressing data but costs more to compute. The paper says that the choice of algorithm depends on the situation in which it will be used. This comparison helps you pick the right strategies for hybrid compression systems.

### 3. METHODOLOGY

**i) Proposed Work:**

The Huffman inspired LZW Lossless Compression of images using Retinex algorithm is a 3-stage compression system. First step: Use Huffman coding to make the image smaller. second step: After putting all the Huffman code words together, use LZW compression and then decode. 1/3 step: Apply Retinex algorithm as a means to enhance contrast and the appearance of an image. The objective of the system will be to achieve higher compression rate, reduce mean square error and maintain the image quality post compression.

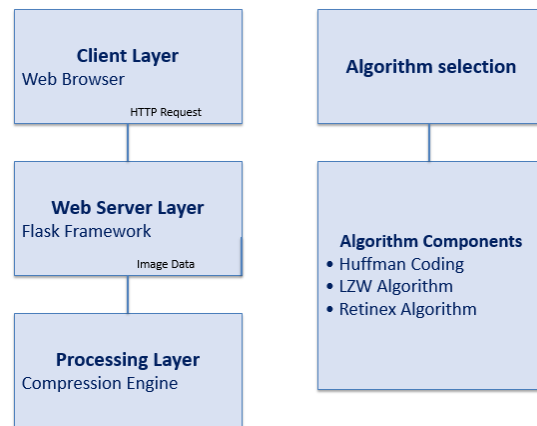
The utilization of the Huffman and LZW compression algorithms in sequential manner would make the proposed system work better in general in terms of compression. Huffman coding relies on the notion of entropy and is effective to eliminate excess symbols. LZW, however, is a dictionary driven algorithm that tries to find instances of repeated strings that can make files even tinier. The system enjoys the best of the two methods and this minimizes the statistical as well as structural redundancy. This causes the storage requirements to decrease significantly. The sequential processing also ensures that the data remains lossless throughout the compression stages. this implies that it can be applied under cases when its image quality is highly critical, e.g. medical imaging, satellite photography and digital archiving.

This solves a common case of Compression systems: loss of visual quality of reduced contrast and detail by adding the Retinex algorithm at the end. Retinex process adjusts the lighting and the contrast of the colors that makes the pictures look better once they are compressed. This action is highly crucial in

ensuring that the quality of the images is good even in situations like there is little light or the mild is not even. The improved visual rendering not just makes the compressed image simpler to utilize, however, it also ensures that indicators of quality such as the PSNR and SSIM remain favorable. The method is efficient and in visual terms it is reliable as it also employs lossless compression as well as the perception augmentation.

**ii) System Architecture:**

There are 3 key layers in the proposed image compression system architecture: the client Layer, the web Server Layer, and the Processing Layer. users upload photos for compression through HTTP requests on the client Layer, which is the part of the program that users see. These requests are delivered to the web Server Layer, which is created on the basis of Flask framework. The layer represents the middleware, which receives picture records, handles sessions, and delivers the data to the backend to process it. Then, the image data will be given to Processing Layer, which does the real compression using pipeline of algorithms defined previously.



“Fig 1 Proposed Architecture”

This section has a module titled algorithm selection that is directly related to algorithmic backbone of the system on the right side of the design, using Huffman Coding, LZW algorithm and Retinex algorithm, this module determines how the compression will be done. The steps begin by Huffman Coding that is used to remove redundant statistical information. Then LZW will compress repetitive patterns and sequences. finally the retinex algorithm will improve appearance of the image after compression by increasing contrast and the ability to see things well. This modular structure allows to process the data fast, administer algorithms flexibly, and employ a powerful compression system, which is effective both in image storage and transmissions to be delivered in real-time.

### **iii) Modules:**

#### **Modules Description**

##### ***Huffman Compression***

The initial method as proposed compression framework is based on the Huffman coding algorithm to remove some superfluous data and to reduce the input picture. The approach used in Huffman coding is to consider the frequencies of the various pixel values used in the image and provide smaller binary strings to the frequently used pixel values and longer binary strings to the less frequently used values. the method allows encoding the visual data faster by focusing on statistical redundancy. Process of getting rid of duplicate and unnecessary pixel data through Huffman coding compacts the image. This enhances the further stages of compression.

##### ***LZW Lossless Compression Algorithm***

In the second step, the data is still further compressed by using LZW (Lempel-Ziv-Welch) algorithm to avoid the loss of information. The number crunch the Huffman-encoded data is what is fed into this stage, in particular, the dictionary generated during the previous stage. LZW operates by detecting patterns, or sequences that occur repeatedly in the Huffman-encoded information and codes it with shorter codes of its own generated on the fly dictionary. This two layer compression retains only data that is most important and unique as well as encodes pixel sequences that are additional and redundant in such a manner that it saves space. The quality of the images does not get compromised in this procedure and so it would be suitable in cases where the integrity of the data is highly significant as in medical or scientific imaging.

##### ***Retinex Algorithm for Image Enhancement***

To make the final image look better the Retinex algorithm is to be applied on the compressed image. An excellent example of how to enhance photos is the Retinex algorithm, which shifts the light and restores natural colors. it also helps to fix photographs that are too dull, low-contrast, or blurry due to poor lighting or compromised compression. Retinex method enhances color correctness and sharpness through duplicating the human eye perception of color and light in diverse situations of illumination. By reducing noise and raising contrast, it makes the output prettier to look at. This part ensures that the end image remains crispy, bright and useful long after it has been compressed.

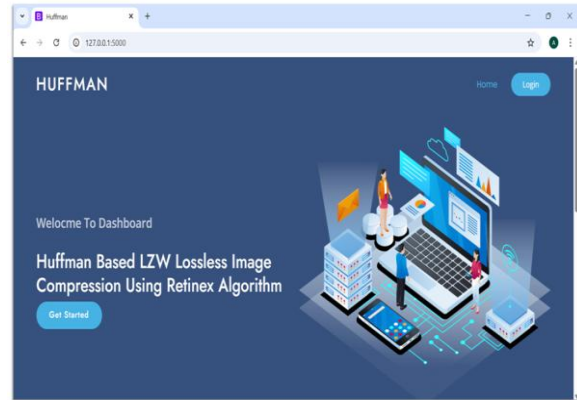
### **iv) Algorithms:**

**Retinex algorithm** is used to make the image contrast better for dynamic compression. Land

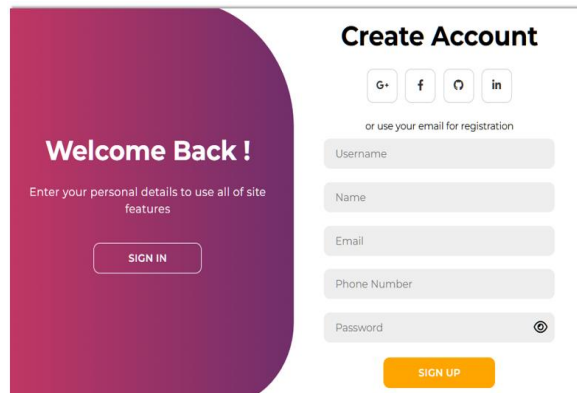
introduces the Retinex theory to describe how people see things and to provide an illumination invariance model that has nothing to do with color. the main goal of the Retinex model is to rebuild images so that the reconstructed image looks the same as what the observer saw at the scene. The Retinex version is based on the reflection imaging illumination model and is very similar to homomorphism filtering. It uses a low-pass filter to estimate the fuzzy computing on the input image. It separates the reflected light from the input image and smoothes the images.

Edwin Land came up with Retinex, which is different from traditional image enhancement algorithms like linear and nonlinear transform, image sharpening, and others that can only improve certain aspects of an image, like making the dynamic range smaller or enhancing the edges of an image. Retinex balances 3 things: compressing the dynamic range of gray-scale, enhancing edges, and keeping colors consistent. it may be used with any sort of image and will automatically enhance itself. the main idea of Retinex is to split an image into parts: a brightness image and a reflection image. Then, to achieve the goal, the images are enhanced by making the brightness of the image have less of an effect on the reflection [15].

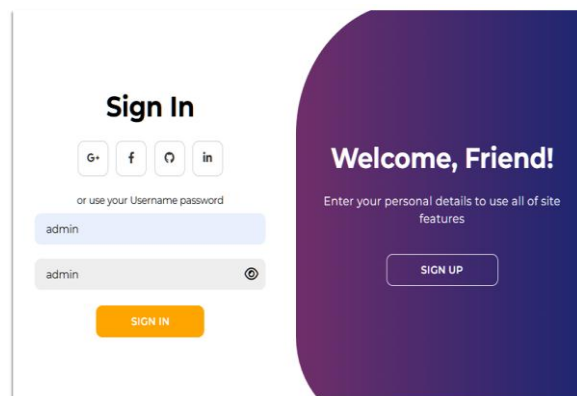
#### 4. EXPERIMENTAL RESULTS



“Fig 2 Home page”

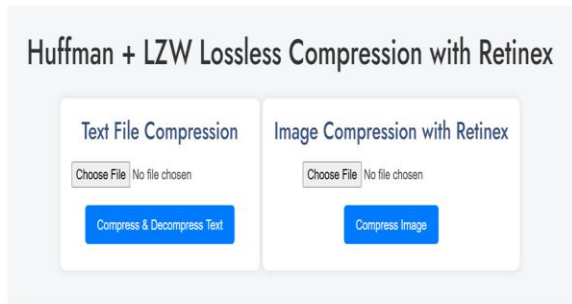


“Fig 3 Signup page”

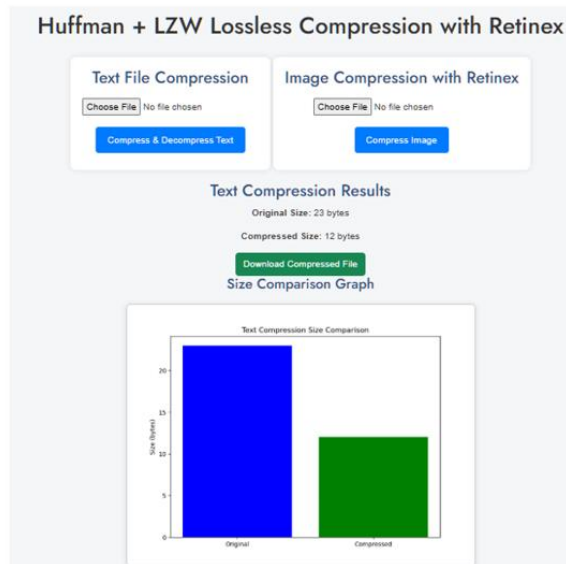


“Fig 4 Signin page”

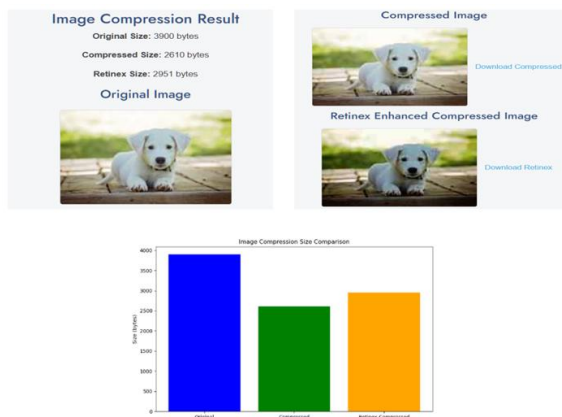
Compression interface



“Fig 5 Compression interface”



“Fig 6 Text compressed with comparison graph”



“Fig 7 Image compressed with comparison graph”

## 5. CONCLUSION

The suggested system, "Huffman inspired LZW Lossless Compression of images using Retinex algorithm," combines 3 steps of compression and enhancement to provide lossless image compression that is both efficient and The system uses Huffman coding and LZW compression to make image files smaller without losing any vital data. It also uses the Retinex technique to make the final output look better. The method gets beyond the problems with typical single-stage compression methods by getting rid of redundancy, encoding efficiently, and improving the image. The experimental results reveal that the suggested multi-stage technique for optimizing storage and transmission works well in practice, as shown by the significant improvements in the “compression rate (CR) and mean square error (MSE) metrics”.

## 6. FUTURE SCOPE

In the future, the system could be improved to better handle color image compression by adding adaptive Retinex models for correcting illumination changes. also, using ML techniques could assist automatically choose the best compression settings based on the features of the image. another avenue for growth could be real-time compression and improvement of high-resolution photos and video streams. also, putting the system on cloud platforms makes it more scalable and efficient because it can store and send large amounts of images with little delay. future studies could potentially look into hybrid models that mix DL with standard lossless methods to make them even faster and more flexible.

## REFERENCES

- [1] Vartika Singh “A Brief Introduction on Image Compression Techniques and Standards” International Journal of Technology and Research Advances Volume of 2013 issue II.
- [2] Mamta Sharmap “Compression Using Huffman Coding” IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.5, May 2010.
- [3] Sindhu M, Rajkamal R “Images and Its Compression Techniques A Review” International Journal of Recent Trends in Engineering, Vol 2, No. 4, November 2009.
- [4] C.Saravanan,R. Ponalagusamy “Lossless Grey-scale Image Compression using Source Symbols Reduction and Huffman Coding”.
- [5] Mayur Nandihalli,Vishwanath Baligar “lossless gray scale images using dynamic array for prediction and applied to higher bitplan” International Journal of Scientific and Research Publications, Volume 3, Issue 1, January 2013.
- [6] R.S.Aarthi, D. Muralidharan, P. Swaminathan “DOUBLE COMPRESSION OF TEST DATA USING HUFFMAN CODE ” Journal of Theoretical and Applied Information Technology 15 May 2012.
- [7] A. Alarabeyyat, S. Al-Hashemi<sup>1</sup>, T. Khdour<sup>1</sup>, M. Hjoui Btoush<sup>1</sup>, S. Bani-Ahmad<sup>1</sup>, R. Al-Hashemi “Lossless Image Compression Technique Using Combination Methods ”Journal of Software Engineering and Applications, 2012.
- [8] Md. Rubaiyat Hasan “Data Compression using Huffman based LZW Encoding Technique” International Journal of Scientific & Engineering Research, Volume 2, Issue 11, November-2011.
- [9] Monika and Pragati Kapoor “A Huffman based LZW Approach to Perform Image Compression” 2007.
- [10] A.Mallaiah, S. K. Shabbir, T. Subhashini “ An Spiht Algorithm With Huffman Encoder For Image Compression And Quality Improvement Using Retinex Algorithm “ International Journal Of Scientific & Technology Research Volume 1, Issue 5, June 2012.
- [11] C. Saravanan, M. Surender “Enhancing Efficiency of Huffman Coding using Lempel Ziv Coding for Image Compression” International Journal of Soft Computing and Engineering (IJSCE) January 2013.
- [12] Mr.D.V.Patil, Mr.S.G.Sutar Mrs.A.N.Mulla.. “Automatic Image Enhancement for Better Visualization using Retinex Technique” International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013.
- [13] Jiang Xing-fanga,b) , Tao Chun-kanb).” Advanced Multi Scale Retinex Algorithm for Color Image Enhancement” International Symposium on Photoelectronic Detection and Imaging 2007.
- [14] Zia-ur Rahman a,<sup>1</sup> Daniel J. Jobson b,<sup>2</sup> Glenn A. Woodell Investigating the relationship between image enhancement and image compression in the context of the multi-scale Retinex b J. Vis. Commun. Image R. 22 (2011) 237–250 science direct.
- [15] Asadollah Shahbahrami, Ramin Bahrapour, Mobin Sabbaghi Rostami, Mostafa Ayoubi Mobarhan, “Evaluation of Huffman and Arithmetic Algorithms for Multimedia Compression Standards”