Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 8, 10060-10067

HYBRID IMAGE COMPRESSION TECHNIQUE USING DEEP LEARNING MODEL FOR ENHANCED RELIABILITY AND DATA TRANSMISSION

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Abstract:

Image compression is the way of data compression which could be applicable to digital form of images for the purpose of reducing the cost of storage or transmission and any algorithm would consider visual perception or statistical properties of an image to establish enhanced results. The compression techniques might be lossy or lossless type. The supreme image quality at a particular compression rate is the major aim of any image compression approach.

Objective: In this current research, image compression is carried out with the support of hybrid Convolution Neural Network (CNN) and Random Forest (RF) approach.

Data description: The proposed methodology is executed in python environment and the performance metrics is evaluated and outcomes attained are compared with existing research works to verify the effectiveness of suggested concept.

Keywords: Convolution Neural Network, Image compression, Random Forest.

I. Introduction

Image compression and image encryption has reached a focus of significant study area as it challenges to assure image security constraints all through the process of image security while an image is been transmitted or stored. In [3], a new image compression-encryption based hybrid approach is presented and however, a "pixel scrambling technique" is deployed to re-encrypt compacted and encoded images.

In [1], a hybrid image processing is presented which is furnished by means of a camera, ultrasonic displacement sensor and a WiFi component. These days, the importance of content shifting management from any source image or video has been an area of research topic since it finds applications in security aspects [2] [4].

In [5], the suggested approach partitions "sub aperture images (SAIs)" of an "LFI" into 2 sets such as "key SAIs and non key SAIs". The results were examined with respect to the rate distortion performance [10].

Nowadays, convolution neural network has been pragmatic to the image enhancement process and an automatic range of low light image enhancement is introduced which is based on a hybrid form of neural network to preserve image nature and create further enhanced outcomes [21]. Four major categories are deployed such as, i) brightening of images by means of content stream which includes encoder and decoder system, ii) integrating edge stream system by merging spatially modified "RNN", iii) addition of minor level of "Gaussian noise" in the training data and iv) perceptual and adversary form of losses to enhance visual quality of outputs [6] [7].

Besides reduction of statistical form of redundancy with the support of entropy coding and transform methods, prediction and quantization based methods were suggested to minimize the "spatial redundancy and visual redundancy" in images [8] [9].

II. Literature Review

An extremely effective means of approach for lossless compression of volumetric arrays of medical images like CT scan or MRI images were suggested in [11] known as 3D-MRP which is based on minimum rate predictors. Moreover, a new double image compression-encryption system is suggested in [12] by joining co-sparse demonstration with random pixel replacing. In [13], 40 such scripts were evaluated and listed into 3 major groups as lossy, lossless and hybrid compression methods and moreover discussed the compression based techniques for handling huge range of data problems related to RLE and transmission level [22]. A coarse-to-fine hyper-prior guided auto-encoder for image compression was presented in [14] and it is mainly developed to decompose images into latent form of representations where the elements present in latent representations could be more effectively encoded or conditionally modelled. Since the detection of malware attacks in industrial based Internet of Things is projected as a major security concern, an enhanced architecture is suggested in [15] for its detection in IIoT environs. A proposed technique is used which could integrate the malware visualization into DCNN model [20] [18].

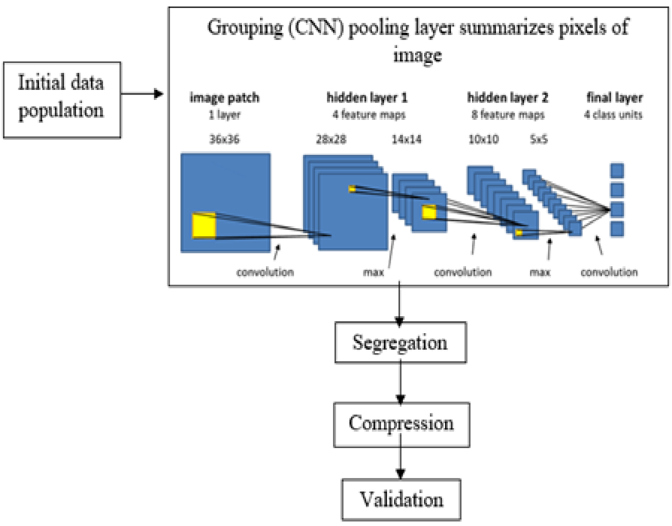
Hybrid systems are assessed for several pictures by discerning with the support of Mean Square Error, Peak Signal to Noise Ratio, Coefficient of Variance, Structural Similarity Index [19] and Mean Structural Similarity Index [16]. Hybrid approach is which it combines advanced properties of each group of methods used and executed in JPEG compression method and here lossy and lossless compression method is used to attain high quality compression ratio while sustaining quality of reconstructed image which is simple, fast and easy to admit. A novel hybrid image compression centred on JPEG standards is present in [17].

III. Proposed Methodology

This section includes the outline of the suggested technique used for image compression with the support of CNN-RF model to execute the image compression efficiently with minimum PSNR. This section also discusses the details about the implementation plan. The subsection includes:

3.1 Proposed workflow flowchart

Figure 1: Proposed Research Method



3.2 Hybrid CNN-RF algorithm

In this proposed CNN-RF approach towards image compression, the initial step is the population size. Here, the pixels of image is the population.

Random Forest algorithm is an ensemble learning technique which could be applied for classification or regression analysis and it operates by developing multiple decision trees at the training phase. Then, the aggregation of results by majority vote factor for classification or average factor for regression. Moreover, the random selection handles complete data with numerous variables running into thousands.

In this research, CNN is deployed for grouping of pixels. In convolution neural network, only a trivial portion of input layer neurons associate to neuron hidden layer. Here, the pooling layer is mainly deployed to minimize the dimensionality of the feature map and there exist numerous multiple activation and pooling layers enclosed within hidden layer of CNN. The fully connected layer forms the previous few layers in the network where the input to the fully connected layer is the output from final pooling or the convolution layer which is compressed and then fed to the fully connected layer. In grouping, depending on the least pixel value, the pixels are grouped and checks for informative and non-informative data.

CNN is an advanced form of multilayer neural network which is mainly entailed of input, hidden and output layers. A neuron is basically an elementary form of information processing unit of a CNN which comprises of a system of synapses or links. Every connection is classified as weight W_1, W_2,..., W_m, an adder function (linear combiner Eq. (1)) which calculates the weighted sum of the inputs,

$$u = \sum_{j=1}^{m} W_j X_j \qquad (1)$$

and activation function f() for controlling the amplitude of the output of the neuron. The typical model of the neuron could be observed as Eq. (2)

$$y = f(u) = f(\sum_{i=1}^{n} W_i X_i - \theta) \qquad (2)$$

Where X_i(i=1,2,3,...,n) specifies the input vector. W_i signifies the weights among 2 connective neurons. θ is the threshold. f() is the activations function, the frequently used function is sigmoid function Eq. (3)

$$f(x) = \frac{1}{1+e^{-kx}} \qquad (3)$$

y is the desired output.

Once the grouping is over, then the image segmentation of pixels takes place in which the image is divided into various subgroups known as image segments that further reduces complexity of image. Following image compression which compresses the image without degrading the quality and essential features of the image. This allows for further images to be stored in a certain volume of disk or memory space.

IV. Results

The results attained for proposed methodology is described in this section with appropriate outputs and performance measures.

Figure 2 denotes the compression ratio between recompressed PNG size ratio and image sorted on compression ratio. The compression ratio was analysed for lossless compression output, lempziv markov with CNN and CNN-RF model. The pseudo code in Figure 3 is the notation for single compression ratio. It can be seen (Figure 2) that the graph varies in gradual manner for CNN-RF which shows the compression efficiency. Figure 4 and 5 denotes the compression table for lempziv markov model.

Figure 2: Compression Ratio

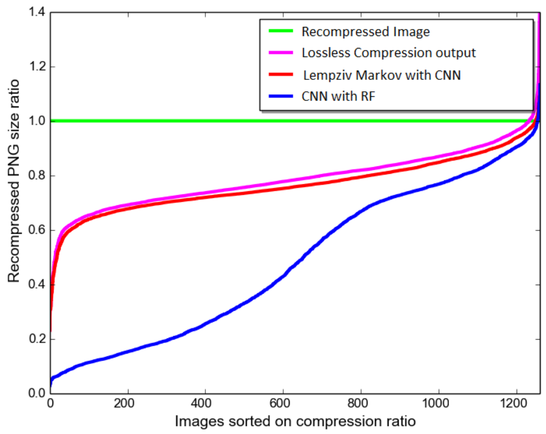
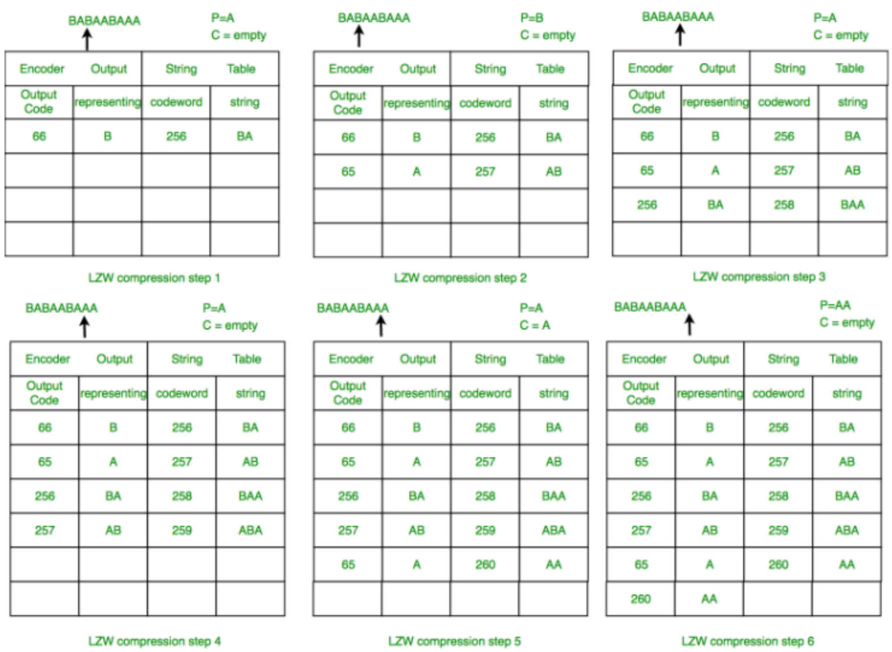


Figure 3: Pseudo code for single compression

```
*       PSEUDOCODE
      Initialize table with single
character strings
      P = first input character
      WHILE not end of input stream
           C = next input character
           IF P + C is in the string
table
             P = P + C
           ELSE
             output the code for P
           add P + C to the string
table
             P = C
           END WHILE
        output code for P
```

Figure 4: Compression Table



BABAABAAA ↑ P=A C = empty

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA

LZW compression step 1

BABAABAAA ↑ P=B C = empty

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA
65	A	257	AB

LZW compression step 2

BABAABAAA ↑ P=A C = empty

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA
65	A	257	AB
256	BA	258	BAA

LZW compression step 3

BABAABAAA ↑ P=A C = empty

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA
65	A	257	AB
256	BA	258	BAA
257	AB	259	ABA

LZW compression step 4

BABAABAAA ↑ P=A C = A

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA
65	A	257	AB
256	BA	258	BAA
257	AB	259	ABA
65	A	260	AA

LZW compression step 5

BABAABAAA ↑ P=AA C = empty

Encoder	Output	String	Table
Output Code	representing	codeword	string
66	B	256	BA
65	A	257	AB
256	BA	258	BAA
257	AB	259	ABA
65	A	260	AA
260	AA		

LZW compression step 6

Figure 5: Compression Table

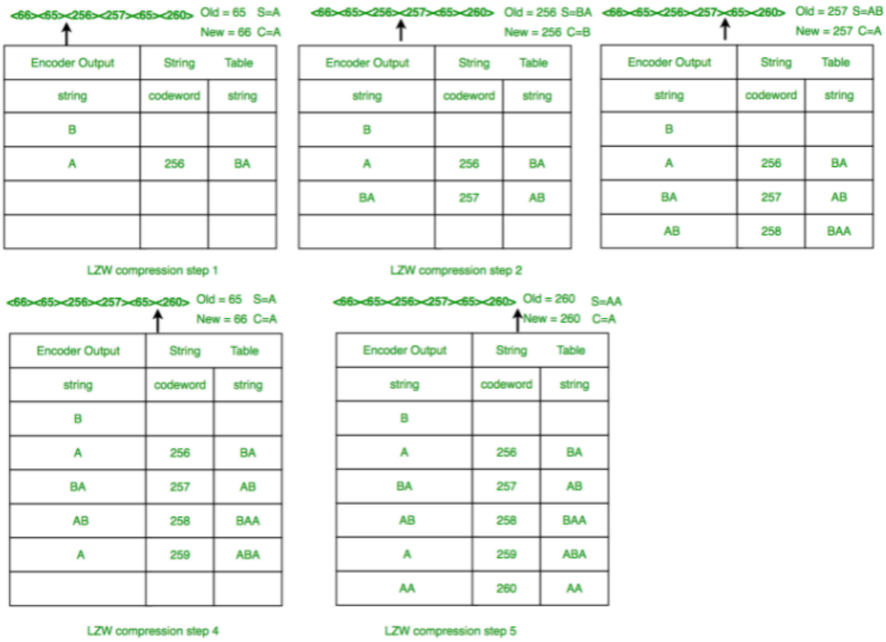


Figure 6 specifies the region growing pattern which shows the possibility of an image while compression because each image gets compressed in a certain level. Figure 7 specifies the compression ratio graph for four iterations. This graph plotted between speed and compression ratio mentions the compression ratio when any image gets compressed. For instance, any image which could be a hardcopy or any big sized image when undergone compression, it should not drop or alter any specific features of the image, particularly in case of medical images. The probable way of compression ratio is described in Figure 7.

Figure 6: Region Growing Pattern

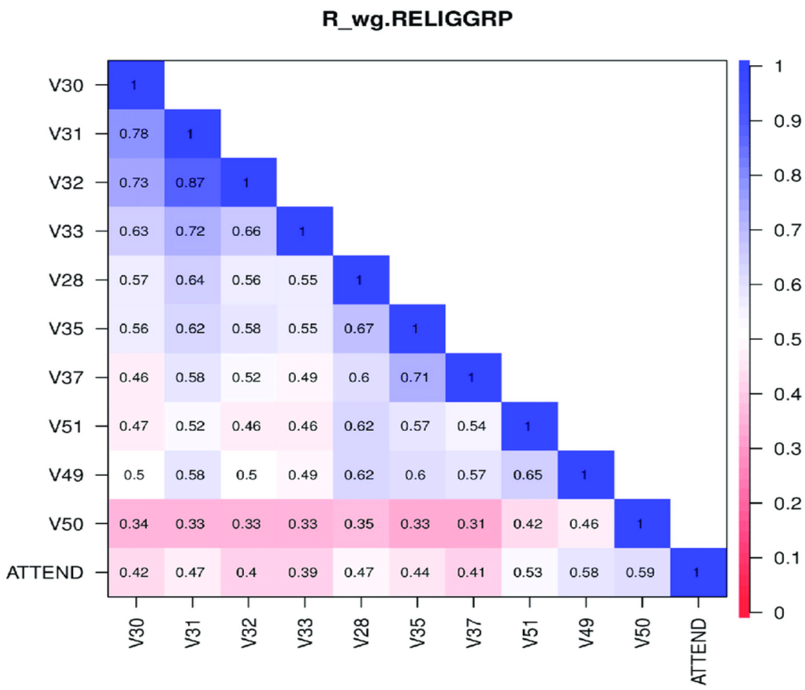


Figure 7: Compression Ratio graph

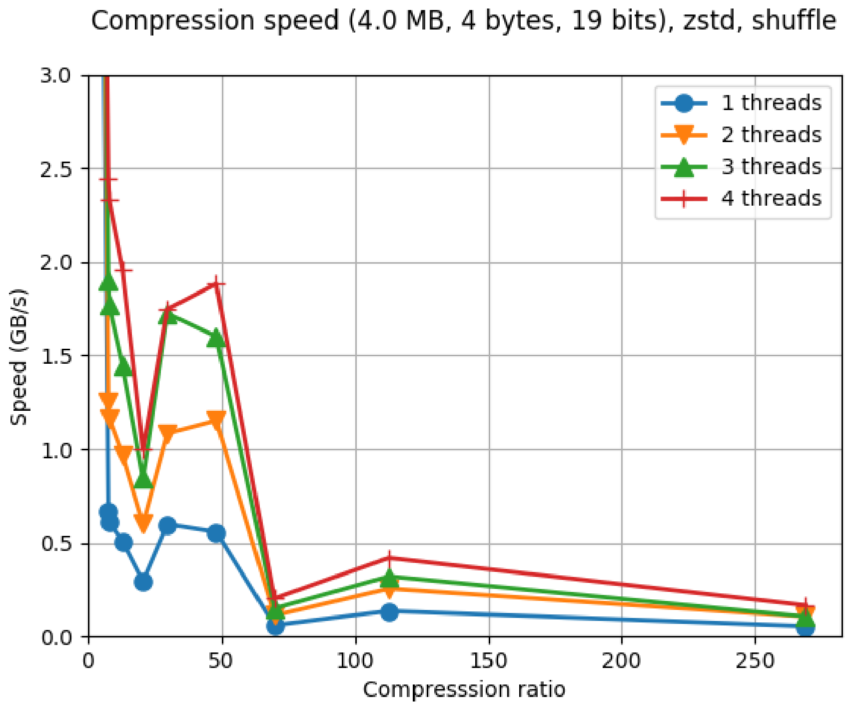


Table 1 denotes the evaluation metrics of the proposed method such as F-Score, Root Mean Square Error (RMSE), Precision, Recall, True Positive (TP), True Negative (TN), False Positive (FP), False Positive (FN) and Peak Signal to Noise Ratio (PSNR) and its comparison with the previous methods. From the table (Table 1), it is clear that the propose method overwhelms earlier approaches in a positive manner.

Table 1: Comparative analysis

Parameters	**RF with CNN**	**Lempziv Markonian with CNN**	**Lossless Compression**
F-Score	0.8	0.5	0.2
Root Mean Square Error	0.75	0.6	0.43
Precision	0.74	0.64	0.58
Recall	0.82	0.53	0.62
True Positive	0.7	0.5	0.7
True Negative	0.2	0.03	0.025
False Positive	0.03	0.3	0.075
False Negative	0.07	0.17	0.2
Peak Signal to Noise Ratio	25.8	22.6	21.6

V. Conclusion

In this current research, the hybrid image compression technique is executed with the aid of Convolution Neural Network (CNN) and Random Forest (RF) approach. The results attained are compared with lempziv markonian with CNN and lossless compression along with performance measures such as F-Score, Root Mean Square Error (RMSE), Precision, Recall, True Positive (TP), True Negative (TN), False Positive (FP), False Positive (FN) and Peak Signal to Noise Ratio (PSNR) were found to be improved with CNN-RF model. Future research work focuses on hybrid combinations of optimization approaches which could enhance the image compression technique further.

Statements & Declarations

Funding

Authors declare that there was no such funds, grants or other support were received during the preparation of this manuscript.

Declaration

We, author(s) of the above titled research paper hereby declare that the work encompassed in the above paper is unique and is a conclusion of the research carried out by the authors specified in it.

Competing Interests

Authors have no significant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to this research work including data analysis, literature survey. The initial draft was prepared by Dr. Bhanu Rekha and reviewed by Dr. Safinaz. Both of the authors read and approved the final draft.

Data Availability

Datasets created during the analysis of current research are available from first author on reasonable request.

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