Watermarking Scheme for Image Processing: A study of Texture Feature Analysis

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Abstract

The digital watermarking is the technique which is used to provide security to sensitive data which is stored in the form of image. The watermarking is the process in which features of the original and sensitive image is calculated and in the second step, the original image is embedded into the watermark image. In this research paper, the neural network based watermarking technique is improved using GLCM and PCA algorithm. The GLCM and PCA algorithm extracts the features of the original image. The output of PCA algorithm defines the scaling factor which is used for the embedding. The proposed algorithm is implemented in MATLAB and simulation results demonstrated that proposed algorithm performs well in terms of PSRN and MSE.

KEYWORDS:
GLCM, PCA, SVD, DWT
1. INTRODUCTION

1.1 Digital watermarking

DIGITAL watermarking is a process in which some information is embedded within a digital media so that the inserted data becomes part of the media. This technique serves a number of purposes such as broadcast monitoring, data authentication, data indexing and so forth. A digital watermarking system must successfully satisfy trade-offs between conflicting requirements of perceptual transparency, data capacity and robustness against attacks. These trade-offs are investigated from an information-theoretic perspective [1]. Watermarks have two categories of roles: In the first category, the watermark is considered as a transmission code and the decoder must recover the whole transmitted information correctly. In the second category, the watermark serves as a verification code. In the latter system, the watermark detector must simply determine the presence of a specific pattern. Since the footprint of the verification watermarking, that is, the number of pixels per watermark code bit is typically higher, this case has higher robustness as compared to the subliminal channel (transmission code) case. In watermarking schemes, the watermark message is embedded in the host signal in different ways, for example, additively or multiplicatively. For about ten years, several reversible watermarking schemes have been proposed for protecting images of sensitive content, like medical or military images, for which any modification may impact their interpretation. These methods allow the user to restore exactly the original image from its watermarked version by removing the watermark. Thus it becomes possible to update the watermark content, as for example security attributes (e.g., one digital signature or some authenticity codes), at any time without adding new image distortions. However, if the reversibility property relaxes constraints of invisibility, it may also introduce discontinuity in data protection. In fact, the image is not protected once the watermark is removed. So, even though watermark removal is possible, its imperceptibility has to be guaranteed as most applications have a high interest in keeping the watermark in the image as long as possible, taking advantage of the continuous protection watermarking offers in the storage, transmission and also processing of the information. This is the reason why, there is still a need for reversible techniques that introduce the lowest distortion possible with high embedding capacity [2]. Since the introduction of the concept of reversible watermarking in the Barton patent, several methods have been proposed. Among these solutions, most recent schemes use Expansion Embedding modulation, Histogram
Shifting modulation or, more recently, their combination. One of the main concerns with these modulations is to avoid underflows and overflows. Indeed, with the addition of a watermark signal to the image, caution must be taken to avoid gray level value underflows (negative) and overflows (greater than for a bit depth image) in the watermarked image while minimizing at the same time image distortion. As analyzed above, the large entropy area is good for watermarking embedding and that is the true hidden channel. In general, entropy masking in watermarking system experiences three steps. Over recent years, there has been tremendous effort in order to understand and model the Human Visual System and applying it to different image processing applications. Such effort has been examined for solving various problems and has resulted in different levels of success. Recently, visual models have been developed as a result of the efforts taken place in the field of image and video compression, which desire to improve the quality of the compression exploiting HVS characteristics. Basically, both image watermarking and image compression are concerned of the image redundancy, which is to be reduced in the case of compression, while is employed to insert the mark in the case of watermarking. As a result, visual models devised in the area of image compression can also be suited to the watermarking problem. Watermark insertion process exploits the weakness of human visual system properties to make the watermark imperceptible with maximal strength [3]. We use Watson visual model as a baseline model to achieve this task. Watson modeled three different properties (weakness) of the human visual system. A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as audio or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners.

Reversible watermarking (RW) methods are used to embed watermarks, e.g., secret information, into digital media while preserving high intactness and good fidelity of host media. It plays an important role in protecting copyright and content of digital media for sensitive applications, e.g., medical and military images. Although researchers proposed some RW methods for various media, e.g., images, audios, videos, and 3-D meshes; they assume the transmission channel is lossless. The robust RW (RRW) is thus a challenging task. For RRW, the essential objective is to
accomplish watermark embedding and extraction in both lossless and loss environment. As a result, RRW is required to not only recover host images and Watermarks without distortion for the lossless channel, but also resist unintentional attacks and extract as many watermarks as possible for the noised channel. Recently, a dozen of RRW methods for digital images have been proposed, which can be classified into two groups: histogram rotation (HR)-based methods and histogram distribution constrained (HDC) methods [2]. The HR-based methods, accomplish robust loss-less embedding by slightly rotating the cancroids vectors of two random zones in the no overlapping blocks. histogram distribution. Unfortunately, these methods suffer from unstable reversibility and robustness according to. In summary, the above analysis shows that both kinds of RRW methods are not readily applicable in practice. Digital watermarking is a technology for embedding various types of information in digital content. In general, information for protecting copyrights and proving the validity of data is embedded as a watermark. A digital watermark is a digital signal or pattern inserted into digital content. The digital content could be a still image, an audio clip, a video clip, a text document, or some form of digital data that the creator or owner would like to protect. The main purpose of the watermark is to identify who the owner of the digital data is, but it can also identify the intended recipient.

Digital watermarking is a technique which allows an individual to add hidden copyright notices or other verification messages to digital audio, video, or image signals and documents. Such hidden message is a group of bits describing information pertaining to the signal or to the author of the signal (name, place, etc.). The technique takes its name from watermarking of paper or money as a security measure. Digital watermarking is not a form of steganography, in which data is hidden in the message without the end user's knowledge, although some watermarking techniques have the steganography feature of not being perceivable by the human eye.

The enormous popularity of the World Wide Web in the early 1990's demonstrated the commercial potential of offering multimedia resources through the digital networks. Since commercial interests seek to use the digital networks to offer digital media for profit, they have a strong interest in protecting their ownership rights. Digital watermarking has been proposed as one way to accomplish this.
Thus, the watermark Embedders and extractor remain synchronized because the extractor will retrieve the same reference image. Herein, we adapt this process to select the most locally appropriate watermarking modulation.

**Fig.1.1:** Histogram shifts modulation. (a) Original histogram. (b) Histogram of the watermarked data.

### 1.2 Purpose of digital watermarking:

Invisible watermarks, on the other hand, are potentially useful as a means of identifying the source, author, creator, owner, and distributor or authorized consumer of a document or image. For this purpose, the objective is to permanently and unalterably mark the image so that the credit or assignment is beyond dispute. In the event of illicit usage, the watermark would facilitate the claim of ownership, the receipt of copyright revenues, or the success of prosecution [10].

Watermarking has also been proposed to trace images in the event of their illicit redistribution. Whereas past infringement with copyrighted documents was often limited by the unfeasibility of large-scale photocopying and distribution, modern digital networks make large-scale dissemination simple and inexpensive. Digital watermarking makes it possible to uniquely mark each image for every buyer. If that buyer then makes an illicit copy, the illicit duplication may be convincingly demonstrated [11].
1.3 Types of Watermarks:

Fig. 1.2: Hierarchy of Watermark
1.3.1 Visible watermarks:

Visible watermarks are an extension of the concept of logos. Such watermarks are applicable to images only. These logos are inlaid into the image but they are transparent. Such watermarks cannot be removed by cropping the center part of the image. Further, such watermarks are protected against attacks such as statistical analysis [11].

1.3.2 Invisible watermark:

Invisible watermark is hidden in the content. It can be detected by an authorized agency only. Such watermarks are used for content and/or author authentication and for detecting unauthorized copier [12].

1.3.3 Public watermark:

Such a watermark can be read or retrieved by anyone using the specialized algorithm. In this sense, public watermarks are not secure. However, public watermarks are useful for carrying IPR information. They are good alternatives to labels [13].

1.3.4 Fragile watermark:

Fragile watermarks are also known as tamper-proof watermarks. Such watermarks are destroyed by data manipulation.

1.3.5 Private Watermark:

Private watermarks are also known as secure watermarks. To read or retrieve such a watermark, it is necessary to have the secret key.

1.3.6 Perceptual watermarks:

A perceptual watermark exploits the aspects of human sensory system to provide invisible yet robust watermark. Such watermarks are also known as transparent watermarks that provide extremely high quality contents [12].

1.3.7 Bit-stream watermark:

The term is sometimes used for watermarking of compressed data such as video.
1.4 Types of Watermarking:

1.4.1 Video watermarking:

Video watermarking can be considered as a superset of normal image watermarking. As such, all the techniques applicable to static images can be applied to video images. However, due to the high frame rate of video, the embedding process must occur almost in real time for live transmissions (it takes a finite time to embed the watermark, which might influence the transmission rate). If the content is generated off-line, this limitation does not exist. A very popular form of on-line (live) video watermarking is the usage of a visible watermark (normally a logo or other distinguishing sign placed in an unobtrusive place on each frame of video [14].

1.4.2 Audio watermarking:

Audio watermarking is currently at the forefront of technology development in an attempt to prevent illegal reproduction and redistribution. One implementation receiving widespread attention is the MP3 approach to audio compression and watermarking.

Audio watermarking can be successfully implemented at frequencies outside the normal human audible range. (This is also the approach followed by compression schemes, in which frequencies outside the human audible range are removed from the original audio soundtrack. [12]

1.4.3 Text watermarking:

Text can be subdivided into two categories: raw unformatted ASCII text and formatted text (typically Postscript, PDF or RTF formats).

Watermark information can be embedded into a formatted document using an approach based on the slight adjustment of inter-line and inter-word spacing’s. Another approach to watermark embedding is to consider the typeset text as one large image and thus to use the typical approaches used for images. One possible approach is based on adding white space characters after each sentence (and is thus hidden to the casual observer). However, this approach is easily bypassed using a normal text editor [4].
1.5 CLASSIFICATION

Digital watermarks are classified according to their applications. The watermarks are classified as perceptible watermarks and imperceptible watermarks, robust and fragile, public and private. This classification of watermarks is broadly described in following sections.

1.5.1 Perceptible watermarks and imperceptible watermarks:
Perceptible watermarks are visible to human eye while imperceptible watermarks are invisible. The perceptible watermarks are useful for primary application i.e. for statement ownership or authorship. So for this reason it should be visible. On the other hand imperceptible watermarks are useful for complex applications such as document identification in which content being watermarked must appear in unchanged from Examples of visible (perceptible) watermarks are logos on TV, IBM watermark and that of invisible (imperceptible) watermarks are ATT, NEC/MIT, UU etc. Perceptible watermarks i.e. visible one are extension of the concept of logos. They are applicable to images only. These watermarks are useful for content or author authentication and for detecting unauthorized copier [12].

1.5.2 Robust watermarks and fragile watermarks:
Robust or fragile is nothing but degree to which watermarks can withstand any modifications of any types caused due to the transmission or loss compression. Perceptible watermarks are more robust in nature than imperceptible one. Robust watermarks are those watermarks which are difficult to remove from the object in which they are embedded. Fragile watermarks are those watermarks which can be easily destroyed by any attempt to tamper with them. Fragile watermarks are destroyed by data manipulation [13].

1.5.3 Private watermarks and public watermarks:
Private watermarks requires at least original data to recover watermark information Public watermarks requires neither original data nor embedded watermarks to recover watermark information. Private watermarks are also known as secure watermarks. To read or retrieve private watermark, it is necessary to have secret key. Public watermark can be read or retrieve by anyone using specialized algorithm. In this sense public watermarks are not secure. Public watermarks are useful for carrying IPR information. They are good alternatives to labels [14].
1.6 Applications of digital watermarking:

- **Ownership Assertion**
  - ‘A’ uses a private key to generate a watermark and embeds it in the document
  - ‘A’ makes the watermarked image publicly available
  - ‘B’ claims that he owns the image derived from the public image
  - ‘A’ produces the unmarked original and establishes the presence of ‘A’s watermark
    [5]

- **Fingerprinting**
  - Used to avoid unauthorized duplication and distribution.
  - A distinct watermark (a fingerprint) is embedded in each copy of the data.
  - If unauthorized copies are found, the origin of the copy can be determined by retrieving the fingerprint [16].

- **Authentication & integrity verification**
  - Watermarks should be able to detect even the slightest change in the document.
  - A unique key associated with the source is used to create the watermark and then embed in the document.
  - This key is then used to extract the watermark and the integrity of the document verified on the basis of the integrity of the watermark.

- **Content labeling**
  - Bits embedded in the data, comprise an annotation, giving some more information about the data.
  - Digital cameras annotate images with the time and date, when the photograph was taken.
  - Medical imaging machines annotate images (X-Rays) with patient's name, ID [22].
• **Usage control & Copy protection**
  - Digital watermark inserted to indicate the number of copies permitted.
  - Every time a copy is made the hardware modifies the watermark and at the same time it would not create any more copies of the data.
  - Commonly used in DVD technology.

• **Content Protection**
  - Content owner might want to publicly and freely provide a preview of multimedia content being sold.

1.7 Advantages of Digital Watermarking:

- Embedding the checksum only changes (on average) half the number of pixel. So less visual distortion.
- Can hold multiple watermarks as long as they don’t overlap.
- Extremely simple and fast.
- Extremely fragile. Any change to the checksum causes the failure of the verification procedure.
- Entire watermark can be removed by removing the LSB plane. Can’t survive lossy compression.

1.8 Limitations of Digital Watermarking:

As of this writing, a counterfeiting scheme has been demonstrated for a class of invertible, feature-based, frequency domain, invisible watermarking algorithms. This counterfeiting scheme could be used to subvert ownership claims because the recovery of the digital signature from a watermarked image requires a comparison with an original. The counterfeiting scheme works by first creating a counterfeit watermarked copy from the genuine watermarked copy by effectively inverting the genuine watermark. This inversion creates a counterfeit of the original image which satisfies two properties [12]:

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a) A comparison of the decoded versions of both the original and counterfeit original yields the owner's (authorized) signature,

A comparison of decoded versions of both the original and counterfeit original yield the forged (inverted) signature. This, the technique of establishing legitimate ownership recovering the signature watermark by comparing a watermarked image with the original image breaks down. It can be shown that both the legitimate signature and counterfeiter's signature inhere in both the watermarked and counterfeit watermarked copies. Thus, while it may be demonstrated that at least one recipient has a counterfeit watermarked copy, it cannot [17].

### 1.9 Watermarking Process

Digital Watermarking software looks for noise in digital media and replaces it with useful information. A digital media file is nothing more than a large list of 0’s and 1’s. The watermarking software determines which of these 0’s and 1’s correspond to redundant or irrelevant details. For example, the software might identify details in an image that are too fine for the human eye to see and flag the corresponding 0’s and 1’s as irrelevant noise. Later the flagged 0’s and 1’s can be replaced by a digital watermark.
The following two sequences of images demonstrate a typical watermark embedding and extraction process applied to a static image. It is notable that a slight degradation of the original image occurs when the watermark is embedded. However, the retrieved watermark is very close to the original watermark, which can help resolve ownership issues [5].

1.9.1 Requirements of Water Marking

To be effective in the protection of the ownership of intellectual property, the invisibly watermarked document should satisfy several criteria:

1. the watermark must be difficult or impossible to remove, at least without visibly degrading the original image,
2. the watermark must survive image modifications that are common to typical image-processing applications (e.g., scaling, color re-quantization, dithering, cropping, and image compression),
3. an invisible watermark should be imperceptible so as not to affect the experience of viewing the image, and
4. For some invisible watermarking applications, watermarks should be readily detectable by the proper authorities, even if imperceptible to the average observer. Such decidability without requiring the original, un-watermarked image would be necessary for efficient recovery of property and subsequent prosecution [4].

2. Review of Literature


In this paper they introduced [1] about implemented a robust image watermarking technique for the copyright protection based on 3-level discrete wavelet transform (DWT). In this technique a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique. The insertion and extraction of the watermark in the grayscale cover image is found to be simpler than other transform techniques. The proposed method is compared with the 1-level and 2-level DWT based image watermarking methods by using statistical parameters such as peak-signal-to-noise-ratio (PSNR) and mean square error (MSE). The experimental results
demonstrate that the watermarks generated with the proposed algorithm are invisible and the quality of watermarked image and the recovered image are improved.

Chun-Shien Lu and Hong-Yuan Mark Liao, “Multipurpose Watermarking for Image Authentication and Protection”, 2001

In this paper they proposed [2] a novel multipurpose watermarking scheme, in which robust and fragile watermarks are simultaneously embedded, for copyright protection and content authentication. By quantizing a host image’s wavelet coefficients as masking threshold units (MTUs), two complementary watermarks are embedded using cocktail watermarking and they can be blindly extracted without access to the host image. For the purpose of image protection, the new scheme guarantees that, no matter what kind of attack is encountered.


In this paper [4] they described about the authenticity & copyright protection are two major problems in handling digital multimedia. The Image watermarking is most popular method for copyright protection by discrete Wavelet Transform (DWT) which performs 2 Level Decomposition of original (cover) image and watermark image is embedded in Lowest Level (LL) sub band of cover image. Inverse Discrete Wavelet Transform (IDWT) is used to recover original image from watermarked image. And Discrete Cosine Transform (DCT) which convert image into Blocks of M bits and then reconstruct using IDCT. In this paper we have compared watermarking using DWT & DWT-DCT methods performance analysis on basis of PSNR, Similarity factor of watermark and recovered watermark.


In this paper author [5] described about the proliferation of digitized media due to the rapid growth of networked multimedia systems, has created an urgent need for copyright enforcement technologies that can protect copyright ownership of multimedia objects. Digital image watermarking is one such technology that has been developed to protect digital images from illegal manipulations. In particular, digital image watermarking algorithms which are based on the discrete wavelet transform have been widely recognized to be more

This paper presents [6] a robust watermarking technique for color and grayscale image. The proposed method involves many techniques to conform a secure and robust watermarking. In the proposed technique the watermark is embedded in 3rd level of DWT.

A Mansouri et.al, “SVD-based digital image watermarking using complex wavelet transform”, 2009

In this paper [7] a new robust method of non-blind image watermarking is proposed. The suggested method is performed by modification on singular value decomposition (SVD) of images in Complex Wavelet Transform (CWT) domain while CWT provides higher capacity than the real wavelet domain. Modification of the appropriate sub-bands leads to a watermarking scheme which favorably preserves the quality.


In this paper, they propose [8] a robust image-in-image watermarking algorithm based on the fast Hadamard transform (FHT) for the copyright protection of digital images. Most current research makes use of a normally distributed random vector as a watermark and where the watermark can only be detected by cross-correlating the received coefficients with the watermark generated by secret key and then comparing an experimental threshold value.


In this paper they proposed [9] both Discrete Cosine Transform (DCT) and Singular Value Decomposition (SVD) have been used as mathematical tools for embedding data into an image. In the DCT-domain, the DCT coefficients are modified by the elements of a pseudo-random sequence of real values. In the SVD domain, a common approach is to modify the singular values by the singular values of a visual watermark. In this paper, we present a new robust hybrid watermarking schemes based on DCT and SVD. After applying the DCT to the cover image, we
3. Present Work

3.1. Problem Formulation

With the rapid growth of internet the various digital methods has been proposed to protect the multimedia information from the non authorized accesses use and change. Among all the proposed methods the watermarking technique is the most common technique for protecting the multimedia data for unauthorized access. The water marking methods have been categorized as spatial domain method and frequency domain method. In spatial domain method we modify the lower order bits of cover image to embed the water mark. The main advantage of this technique is of low complexity and less computational values. But this technique is very robust to certain types of security attacks. The second method is frequency domain transform method. These methods are based upon the using of some invertible transformations like discrete cosine transform i.e. DTC. Discrete Fourier transforms (DFT) and Discrete Wavelet Transform (DWT) to host image. To embed the water mark in the image simply changes the coefficient value of these transforms according to the watermark and the inverse transform is applied to the original image. These methods are too complicated and require more computational power. These methods are also provides more reverts to the security attacks. The another method is GLCM technique.

3.2. Objectives of Research

The main objectives are:

1. To analyze the properties of existing watermarking algorithm i.e. DWT.
2. To propose improvement in the watermarking technique to generate a blind watermark.
3. The proposed technique will be based on the GLCM algorithm to analyze features of the original image .
4. To implement proposed technique and compare it with existing technique ,i.e., DWT in terms of PSNR, BER and MSE.
3.3. Research Methodology

The watermarking is the efficient technique to provide security to the image data. The watermarking techniques are broadly classified into blind and semi-blind watermarking techniques. In the base paper, the semi-blind watermarked image is generated using the OS-ELM technique which is the machine learning technique. The four levels DWT technique is applied to extract the features of the original and watermark images. The training images which is analyzed with the DWT algorithm is given as input to generate final training sets for the generation of semi-blind watermarks. The DWT algorithm will analyze textual features of the images which can be replaced with the glcm algorithm which has less complexity and easy to generate training sets for the generation of blind watermarks.

Fig 3: Proposed Flowchart of embedding
Fig 4: Proposed Flowchart for extraction

The proposed algorithm can be applied in the following steps:-

1. Pre-processing Phase: - In the pre-processing phase, the two image are taken as input. The first image is the original image and second image is the image which need to encrypt. The first image is used to generate key and second image will be encrypted with the key of first image.

2. Feature Extracted: - In the second phase, the textual features of the first image is extracted using the glcm algorithm. The glcm algorithm will extract the features like energy, entropy etc. image.

3.4 GLCM algorithm

1. Count all the number of pixels in the matrix in which the data is saved.

2. Store the counted pixels in matrix P[i,j].

3. Check similarity between pixels in the matrix by applying histogram technique.

4. Calculate contrast factor from the matrix:

\[
g = \exp\left(\frac{\text{mean}(I) - \text{minimum}(I)}{\text{maximum}(I) - \text{mean}(I)}\right)
\]

5. The elements of g need to be normalized by dividing the pixels.

\[
g = \begin{cases} 
0.8 & \text{if } g < 0.8 \\
1.2 & \text{if } g > 1.2 \\
g & \text{otherwise}
\end{cases}
\]
Results and Discussions

4.1 Introduction to MATLAB

MATLAB is a Matrix Laboratory. It is an interactive program which provides numerical computation and visualization of data. With the help of its programming capabilities it provides tool which is very useful for all areas of science and engineering.

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms, functions, and apps for image processing, analysis, visualization, and algorithm development. You can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration. Many toolbox functions are multithreaded to take advantage of multicore and multiprocessor computers.

Result Comparison

<table>
<thead>
<tr>
<th></th>
<th>Parameter values</th>
<th>Base</th>
<th>Proposed</th>
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<tr>
<td>Watermarked image</td>
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<tr>
<td>PSNR</td>
<td>13.3917</td>
<td>18.0129</td>
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<tr>
<td>MSE</td>
<td>3001.26</td>
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<td>Correlation Coefficient</td>
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<tr>
<td>Entropy</td>
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<td>Contrast Attack</td>
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<td>PSNR</td>
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<td>MSE</td>
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<td>Correlation Coefficient</td>
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<tr>
<td>BER</td>
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<tr>
<td>MSE</td>
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Table 1: Result comparison
REFERENCES


