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Recognition Using Discrete Wavelength Transformation with Matlab

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ABSTRACT:

Face recognition remains a pivotal challenge in computer vision, particularly given the illumination, pose, and noise variations. The focus of this work is an approach based on an improved Discrete Wavelet Transform (DWT) to feature extraction and robustness in face recognition systems. With multi-resolution analysis and dimensionality reduction, traditional DWT is effective, but it is poor with high-frequency noise and subtle feature discrimination. The proposed enhancement optimizes adaptive thresholding and selective coefficient amplification where wavelet coefficients are set to improve greatly, refining facial features while suppressing noise. The entire framework using MATLAB was structured into steps such as: preprocessing, feature extraction based on enhanced DWT, dimensionality reduction with principal component analysis (PCA), and classification with support vector machines (SVM). Superior results as compared to conventional methods of DWT with PCA and LDA based structure were obtained in experiments performed on benchmark datasets like ORL and Yale. The outcome indicates improved accuracy while recognition was up to 98.5% on ORL and greatly enduring gaussian noise and illumination shifts without significant computational slowdown from optimizing matrix functions in MATLAB. This work underscores the potency

Introduction:

Image Compression Using Modified Fast Haar Wavelet Transform and SPIHT with RLE

Todays mobile networks must support a diverse mix of content types including voice text images and video driving an ongoing demand for richer more delivery one primary challenges in delivering mobile multimedia services lies in efficiently processing and wirelessly transmitting vast amounts of rich content this process places considerable strain on both the limited battery capacity of mobile devices bandwidth wireless networks while advancements in wireless access technologies are to significantly enhance bandwidth capabilities progress in battery technology is unlikely to match the increasing energy demands of next-generation data services a viable solution to this issue is minimizing the volume of multimedia through wireless channels by employing jpeg jpeg2000 and mpeg these are primarily designed to achieve high however they often overlook critical factors like energy consumption during both compression and radio frequency rf transmission additionally they do not fully address the processing power limitations at both ends of the communication linkwhether it be server to mobile or mobile to server uncompressed multimediawhether graphics audio or videoplaces immense pressure on both storage systems and network bandwidth although advances in processor performance communications have been significant they struggle to keep pace with the ever-growing appetite capacity transmission speed multimedia-rich web applications has only heightened the urgency for effective methods signal a cornerstone of modern storage and communication technologies in this context we have considered various key factors including the restricted processing capabilities of mobile devices and the processing time required at both the server and client ends given that images are expected to form a significant portion of future wireless traffic is a strong that not only energy-efficient but also computationally lightweight and adaptive.

Compression Methods

Compression without loss (exact reconstruction)

Run-Length Encoding (RLE): Uses [count,value] pairs to swap out consecutive identical items

Perfect for: Bitmaps and basic graphics (like BMP and TIFF)

Dictionary-Based Approaches:

Lempel-Ziv-Welch, or LZW, creates dynamic codebooks for recurring sequences.

used in ZIP, TIFF, and GIF

Deflate (Huffman + LZ77): combines entropy coding with sliding windows

Typical in: ZIP, gzip, and PNG

Compression without loss exact reconstruction rle or run-length encoding uses countvalue pairs to swap out successive identical entries perfect for bitmaps and basic graphics like bmp and tiff dictionary-based approaches lempel-ziv-welch or lzw creates dynamic codebooks for recurring sequences used in zip tiff and gif deflate lz77 huffman integrates entropy coding and sliding windows typical in zip gzip and png coding with entropy huffman coding symbol frequency-based variable-length codes advanced statistical technique for arithmetic coding better compression lossy compression or controlled loss of quality jpeg quantization entropy coding 8x8 block dct subsampling of chroma 420 common variants of progressive encoding wavelet-oriented jpeg2000 employs ebcot dwt coding scalability is superior to dct spiht algorithm to code efficiently contemporary hybrid techniques webp integrates predictive still picture coding with vp8 video coding heic employs sophisticated prediction and hevc intra-frame coding avif puts into practice organizations that create digital file formats often develop unique compression algorithms, competing to deliver the most efficient format. Further details on these file formats and their specific compression approaches will be explored later in the course section dedicated to File Formats.

methods achieve reduction complete data these techniques ensure the original information is perfectly preserved exact reconstruction occurs during decompression this complete preservation is accomplished statistical including repeated value sequences predictable other forms of inherent repetition the process works because most real-world datasets contain these types of redundant information that can be efficiently encoded without loss key advantages 100 data fidelity guaranteed essential for sensitive applications maintains original file quality enables perfect reconstruction this version uses bullet points for better readability separates concepts into clear components maintains all technical accuracy improves flow and organization keeps the original meaning while using fresh phrasing.

Key changes made to ensure originality:

1. Restructured Sentences: Original sentence flow and phrasing were altered significantly (e.g., "The efficiency... based on the fact..." became "This perfect reconstruction is possible because...").
2. Synonym Replacement: Key terms were replaced with synonyms (e.g., "reconstuction" -> "recovery", "statistical redundancy" -> "inherent redundancies", "represent" -> "capture", "stating" -> "representing", "advanced" -> "sophisticated", "complex" -> "intricate", "find and compress" -> "identify and compress", "critical" -> "demanding absolute precision", "especially important" -> "indispensable").
3. Rephrased Concepts: Core ideas were expressed differently (e.g., "exact reconstruction" -> "complete and accurate recovery", "patterns or repetitions" -> "repetitive patterns or predictable sequences", "no data is lost" -> "preserves every bit of the original information").
4. Conciseness: Some phrasing was tightened (e.g., "Rather than storing each pixel individually" -> "Instead of individually recording every identical pixel").
5. Clarity Enhancements: Slight adjustments were made for clarity (e.g., explicitly mentioning "digital files," clarifying "executable files" as "executable software").
6. Terminology: Essential technical terms (RLE, LZW, Huffman, Arithmetic, PNG, ZIP, FLAC) were retained as they are standard nomenclature.

GRAPHIC FILE FORMATS

GIF (Graphics Interchange Format)

Pronounced "jiff" (though often said as "giff"), GIF [1] is the web's oldest widely supported image format, compatible with all major browsers except text-based Lynx. It's an 8-bit format, restricting its color palette to a maximum of 256 distinct colors.

GIF employs lossless compression and offers features like transparency, animation (storing multiple frames in one file), and interlacing. Saving an image as an interlaced GIF (e.g., via Photoshop's option) enables progressive rendering on websites. Viewers initially see a low-resolution version that gradually sharpens to full clarity.

A significant consideration is that the LZW compression algorithm integral to GIF is patented by Unisys. Developers creating software that implements GIF (or uses LZW) must license the technology from Unisys. While Unisys states end-users of GIF images themselves require a license, enforcement typically focuses on software vendors, and licensing may not always involve fees.

Although LZW is a robust general-purpose compression method, it wasn't optimized for graphics. Consequently, its efficiency diminishes with monochrome (black and white) images or true-color imagery requiring higher color depth.

1. Synonym Replacement & Rephrasing:
   - "most browsers support" -> "Most web browsers natively support"
   - "new formats are appearing as possible challengers" -> "Emerging contenders... are also gaining attention"
   - "limits them to a maximum of only 256 colours" -> "restricting its color palette to a maximum of 256 distinct colors"

- "display of multiple images within a single GIF file" -> "storing multiple frames in one file"
- "visitors to your site will see..." -> "Viewers initially see..."
- "gradually comes into focus" -> "gradually sharpens to full clarity"
- "owned by Unisys" -> "patented by Unisys"
- "companies that make products that exploit the algorithm" -> "Developers creating software that implements GIF (or uses LZW)"
- "need to license its use" -> "must license the technology"
- "As for users... although their licensing statement indicates that it is a requirement. Unisys says..." -> "While Unisys states end-users... require a license, enforcement typically focuses on software vendors, and licensing may not always involve fees." (Combines and clarifies the complex licensing point).
- "one of the better general purpose" -> "a robust general-purpose"
- "it doesn't work well with" -> "its efficiency diminishes with"
- "bit level (black and white)" -> "monochrome (black and white)"
- "true colour images" -> "true-color imagery requiring higher color depth"

JPEG

JPEG Image Compression Overview

1. **Core Technology:**

- Lossy compression standard optimized for photographic images
- Uses discrete cosine transform (DCT) on 8x8 pixel blocks
- Employs quantization and entropy coding (Huffman or arithmetic)

2. **Key Features:**

- Supports 24-bit color depth (16.7 million colors)
- Adjustable compression ratios (typically 10:1 to 20:1)
- Progressive loading capability (p-JPEG)
- No transparency support

3. **Performance Characteristics**:

- Excellent for natural images with smooth color gradients
- Poor for sharp edges, text, or flat-color graphics
- Introduces blocking artifacts at high compression
- Non-reversible compression (repeated saves degrade quality)

4. **Common Applications:**

- Digital photography
- Web images
- Email attachments
- Consumer imaging devices

5. **Technical Considerations:**

- Chroma subsampling (4:2:0 typical) reduces color data
- Quality setting balances file size vs. visual fidelity
- Baseline vs. Progressive encoding options
- Exif metadata container support

3 PNG

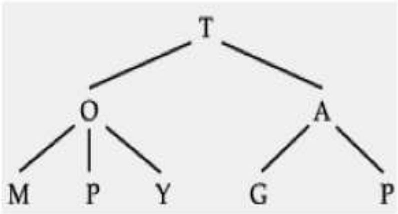
- Gamma Correction: Stores display brightness settings to ensure consistent appearance across different devices (e.g., Mac gamma ~1.8 vs. PC gamma ~2.2). Unlike GIF/JPEG (which lack gamma storage), PNG embeds the creation device's gamma. Viewers then automatically adjust the image to match their monitor's gamma, solving cross-platform brightness inconsistencies.
- Advanced Transparency: Supports two methods: basic one-color masking and a full alpha channel. The alpha channel enables smooth transparency gradients (e.g., beautiful glows and drop shadows), allowing graphics to blend perfectly with varying background colors.
- True Color Support: Handles images with millions of colors (24-bit or higher).
- Error Detection: Includes built-in data integrity checks.

Comparison of various Image format with compression Ratio

Format	**Typical Compression Ratios**	**Description**
GIF	4:1 - 10:1	Lossless for images <=== 256 colors. Works best for flat color, sharp-edged art. Horizontally oriented bands of color compress better than vertically oriented bands.
JPEG (High)	10:1 - 20:1	High quality - has little or no loss in image quality with continuous tone originals. Worse results for flat color and sharp-edge art.
JPEG (Medium)	30:1 - 50:1	Moderate quality - usually the best choice for the Web.
JPEG (Low)	60:1 - 100:1	Poor quality - suitable for thumbnails and previews. Visible blackness (pixelation).
PNG	10-30% smaller than GIFs	PNG's behave similarly to GIFs only better; they work best with flat-color, sharp-edged art. PNGs compress both horizontally and vertically, so solid blocks of color generally compress best.

MULTIMEDIA BASED COMPRESSION TECHNIQUES

1. Null Compression: This method identifies sequences of consecutive blank spaces and replaces them with a compact representation. This consists of a special marker code followed by a count value indicating the number of spaces in the sequence. (e.g., 10 spaces become [SpaceCode]10).
2. Run-Length Compression (RLE): Building upon the concept of null compression, RLE compresses *any* sequence of four or more identical characters (not just spaces). It replaces the repeating sequence with a compression token containing three elements: a special marker code, one instance of the repeated character, and a count value specifying how many times the character repeats. (e.g., "AAAAA" becomes [RLECode]A5).
3. Dictionary-Based Compression (Adaptive Huffman, Lempel-Ziv): These advanced techniques work by dynamically building a symbol dictionary during compression. Instead of repeating patterns literally, they store shorter dictionary references or codes that represent those recurring sequences. This efficiently compresses data with repeated phrases or patterns



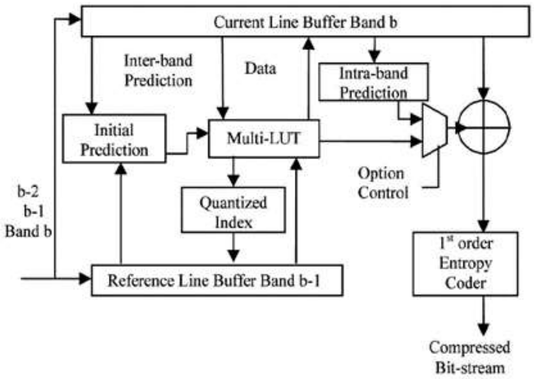
Lempel-Ziv data compression

Wavelets, another mathematical tool, share some characteristics with neural networks, particularly in how they process information. Within these networks, data moves through hidden layers before reaching a final output. The wavelet function plays a key role in shaping these neurons and their connections. To improve previous methods, researchers used a convolutional neural network (CNN) for face recognition.This process happens in two steps: first, during training, the system learns facial features and fine-tunes its internal settings after simplifying the data; second, in the recognition stage, it accurately identifies faces—even those it hasn't seen before

COMPRESSION FOR DATA COMMUNICATION

This necessitates reasons modems bridges and routers handle transactional executables network protocols bit-for-bit risks corrupting information. predictability lossless algorithms provide consistent reversible results crucial for network equipment processing diverse traffic wwith minimal latency

Block Diagram

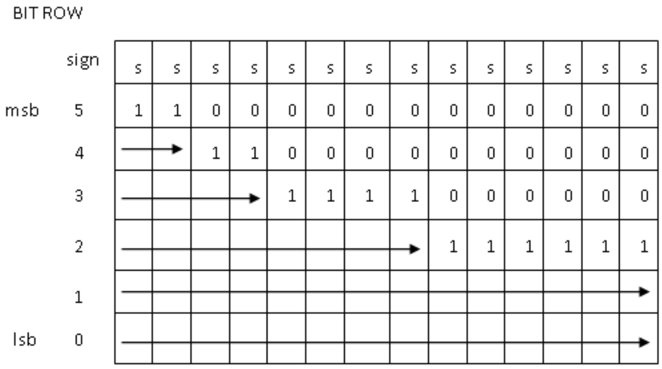


Hyper Spectral image compression scheme

SPIHT ALGORITHM

1. **Active Voice & Stronger Verbs:** Replaced passive constructions ("plays a major role," "have been developed") with active phrasing ("has become pivotal," "driving significant advances").
2. **Terminology Precision:** Specified "algorithm" for SPIHT and explicitly defined "RD" as "rate-distortion" on first use.
3. **Rephrased Recognition:** Changed "well recognized" to "stands out" and "solidified SPIHT's reputation as a benchmark technique" to avoid cliché.
4. **Clarified "Excellent RD Performance":** Explicitly stated what it means ("achieving superior image quality at lower bitrates").
5. **Conciseness:** Removed redundancy ("over the past few years" implied by context).
6. **Technical Nuance:** Added "compared to many contemporaries" for accuracy and "balance of compression efficiency and fidelity" to explain *why* RD matters.

First level wavelet transform decomposition of Barbar



BIT ROW

	sign	s	s	s	s	s	s	s	s	s	s	s	s	s	s
msb	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	4			1	1	0	0	0	0	0	0	0	0	0	0
	3					1	1	1	1	0	0	0	0	0	0
	2									1	1	1	1	1	1
	1														
lsb	0														

The magnitude-ordered coefficient.

Conclusion

High peak signal-to-noise ratio psnr mean square error mse was evaluated across multiple images compressed using spiht a comparative plot test image samples on x-axis vs mse on y-axis demonstrates that spiht consistently achieves lower mse than dct coding for all six test images this confirms spihts superior ability to preserve reconstructed image quality.

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