

# Real-Time Face Retrieval Using Binary Hashing on QNX

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## What ?

This work presents a real-time face image retrieval system designed for resource-constrained environments.

- Converts face images into compact binary representations using Wavelet Hashing.
- Enables fast similarity search via Hamming distance-based matching.
- Operates efficiently on a real-time operating system (QNX) without deep learning.

## Why ?

- Deep learning based face retrieval methods provide excellent accuracy but typically depend on large labeled datasets, GPU acceleration, and heavy computation, which increases deployment cost, energy consumption, and latency, making them impractical for real time embedded systems with strict timing constraints and limited hardware resources availability.
- This work focuses on **lightweight, real-time, and resource-efficient** face retrieval.

## Overview

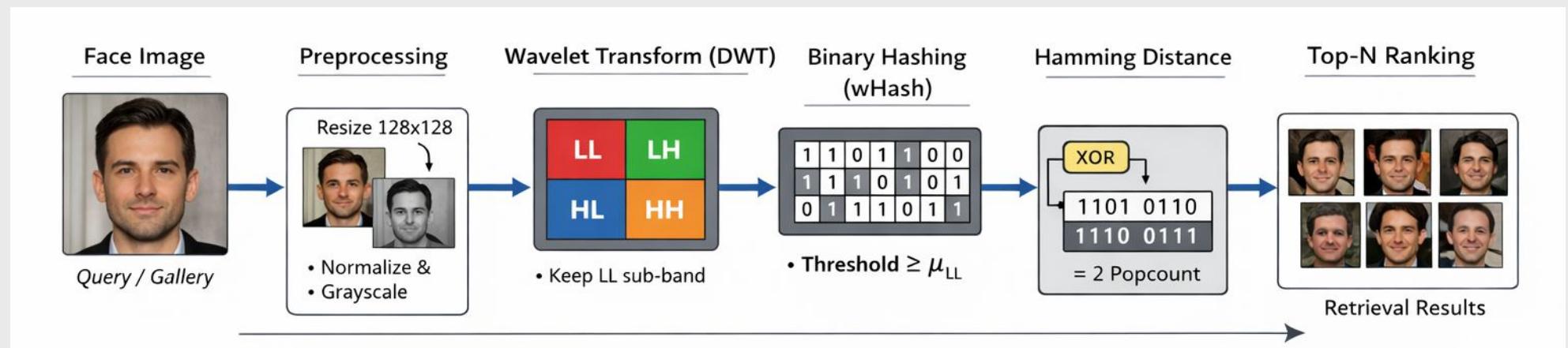


Figure 1 . Face Image Retrieval Pipeline Based on Wavelet Hash (wHash)

## Description

### 1. Face Image Preprocessing

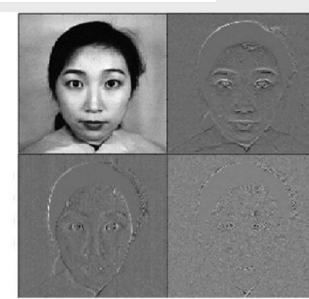
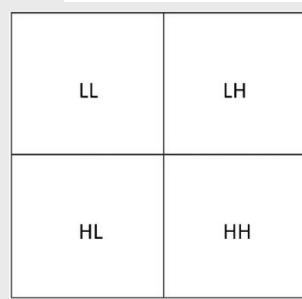
- Each input face image is normalized to ensure consistency across the dataset. Images are resized to a fixed resolution (e.g., 128×128), converted to grayscale to reduce dimensionality, and optionally cropped or aligned to focus on the facial region. Grayscale intensity is computed as a weighted sum of RGB channels.
- Grayscale conversion is computed as:

$$I_{\text{gray}}(x, y) = 0.299R(x, y) + 0.587G(x, y) + 0.114B(x, y)$$

### 2. Feature Extraction via Wavelet Hash (wHash)

- The normalized image is decomposed using Discrete Wavelet Transform (DWT) into four sub-bands (LL, LH, HL, HH). The LL sub-band, which preserves global facial structure, is retained. Binary features are generated by thresholding LL coefficients against their mean value, forming the wavelet hash.
- Binary hashing is generated by thresholding LL coefficients with their mean value:

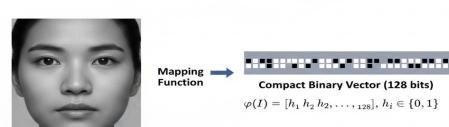
$$h(x, y) = \begin{cases} 1, & LL(x, y) \geq \mu_{LL} \\ 0, & LL(x, y) < \mu_{LL} \end{cases}$$



### 3. Binary Hash Representation

- Each face image is mapped to a compact binary vector of fixed length (typically 64 or 128 bits). This representation significantly reduces storage requirements and enables efficient large-scale comparison.
- Each face image  $I$  is mapped into a compact binary vector:

$$\varphi(I) = [h_1, h_2, \dots, h_m], \quad h_i \in \{0, 1\}$$



### 4. Similarity Measurement Using Hamming Distance

- The similarity between a query image  $Q$  and a database image  $I$  is measured using Hamming distance:

$$d_H(Q, I) = \sum_{i=1}^m |h_Q(i) - h_I(i)|$$

- A smaller distance indicates higher similarity.
- Images are ranked in ascending order of  $d_H$  to retrieve the Top-N most similar faces.

