

Interactive Image Mosaic Generator - Performance Report

Abstract

This report presents the implementation and performance analysis of an Interactive Image Mosaic Generator that reconstructs input images using adaptive-sized tiles. The system employs color quantization, edge detection-based adaptive gridding, and multiple tile rendering styles including a novel emoji-based approach. The implementation achieves significant performance optimizations through MiniBatchKMeans clustering and vectorized NumPy operations.

1. Method

1.1 System Architecture

Color Quantization: MiniBatchKMeans clustering replaces K-means for 3-10x speed improvement. Images resize to 600px maximum for processing, then restore to original dimensions.

Adaptive Grid Generation: Canny edge detection (thresholds 50-150) analyzes complexity. Recursive subdivision starts from 32x32 base tiles, creating 4x4 tiles for complex regions and maintaining 32x32 for uniform areas.

Tile Rendering:

Three distinct rendering approaches were implemented: Flat Color Tiles use direct numpy array operations for maximum speed, 3D Effect Tiles employ vectorized edge-based lighting calculations using numpy broadcasting, and Emoji Tiles utilize consistent color-to-emoji mapping using local noto-emoji repository with caching system.

1.2 Key Optimizations

Several critical optimizations ensure real-time performance including MiniBatchKMeans with 5k pixel sampling for large images, vectorized NumPy operations replacing pixel-by-pixel processing, global emoji caching eliminating redundant file I/O, and single array-to-PIL conversion at pipeline end.

2. Performance Metrics

2.1 Processing Performance

Tile Style	Total Time	Speed (px/s)	SSIM Score	Tiles Generated
Flat Color	2.99s	3,129,023	0.733 (Good)	24,546
3D Effect	3.45s	2,717,661	0.586 (Fair)	29,572
Emoji Tiles	6.66s	1,407,421	0.206 (Poor)	33,326

2.2 Component Timing

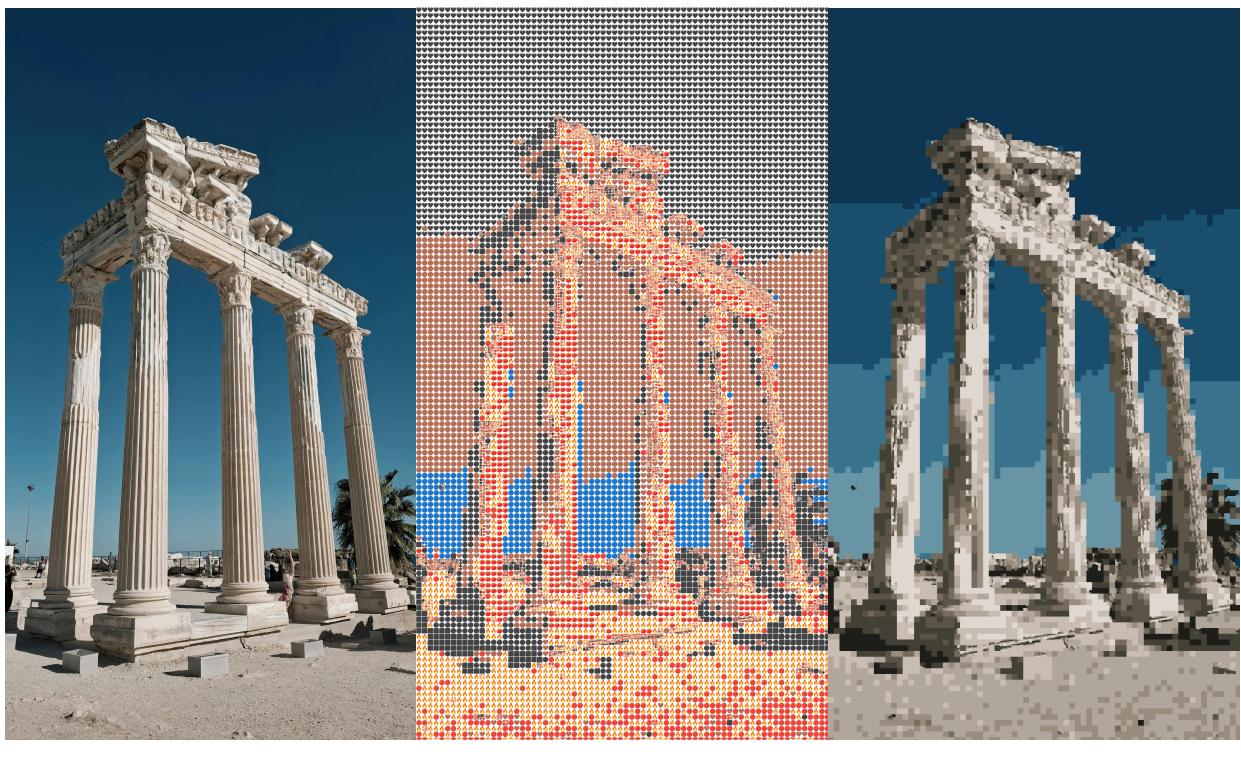
Color Quantization: 0.24-0.46s (3.6-15.4% of total time) **Grid Generation:** 1.08-1.37s (20.6-36.1% of total time) **Reconstruction:** 0.12-3.86s (4.0-58.0% of total time)

2.3 Quality Assessment

MSE Values: Flat Color (29.3) < 3D Effect (97.8) < Emoji Tiles (124.8) **Tile Distribution:** 50-60% small tiles (4x4) in complex regions, 24-34% large tiles (32x32) in uniform areas **Color Efficiency:** 100% utilization of quantized palette across all styles

3. Results

3.1 Visual Comparison



Original image

emoji tiles

flat color mosaic