Emotion-Based Style Transfer

An Innovative ML Approach to Visual Emotion Recognition and Artistic Style Application

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💡 Background & Significance

Traditional image style transfer focuses on low-level features like textures and colors without considering emotional content. However, the core value of artistic works lies in their ability to evoke emotional responses.

Key Insight:

Integrating emotional cognition into image style transfer creates artistic effects with greater emotional resonance and more personalized visual experiences.

🧠 Problem Definition

01

How can we effectively map emotional states to corresponding visual representations?

02

Can we create an automated system for style transfer based on emotional context?

Key Assumptions

Emotion Quantification

Images can be analyzed to extract probability distributions across six basic emotions based on their visual characteristics including color, texture, composition, and other learnable features.

Artwork Emotion Mapping

The emotional characteristics of artworks in the WikiArt dataset, derived from human subject interviews, can be represented as probability distributions across the same emotional dimensions.

Emotional Correspondence

Visual style transfer between images with similar emotional distributions will result in more meaningful and resonant artistic transformations.

System Architecture

Our emotion-based image style transfer system consists of three main components working in sequence to transform user-uploaded images into emotionally resonant artwork.

Input Image

User-uploaded content

→

Emotion Analyzer

Extracts emotion probabilities

→

Similarity Matcher

Finds emotionally similar artwork

→

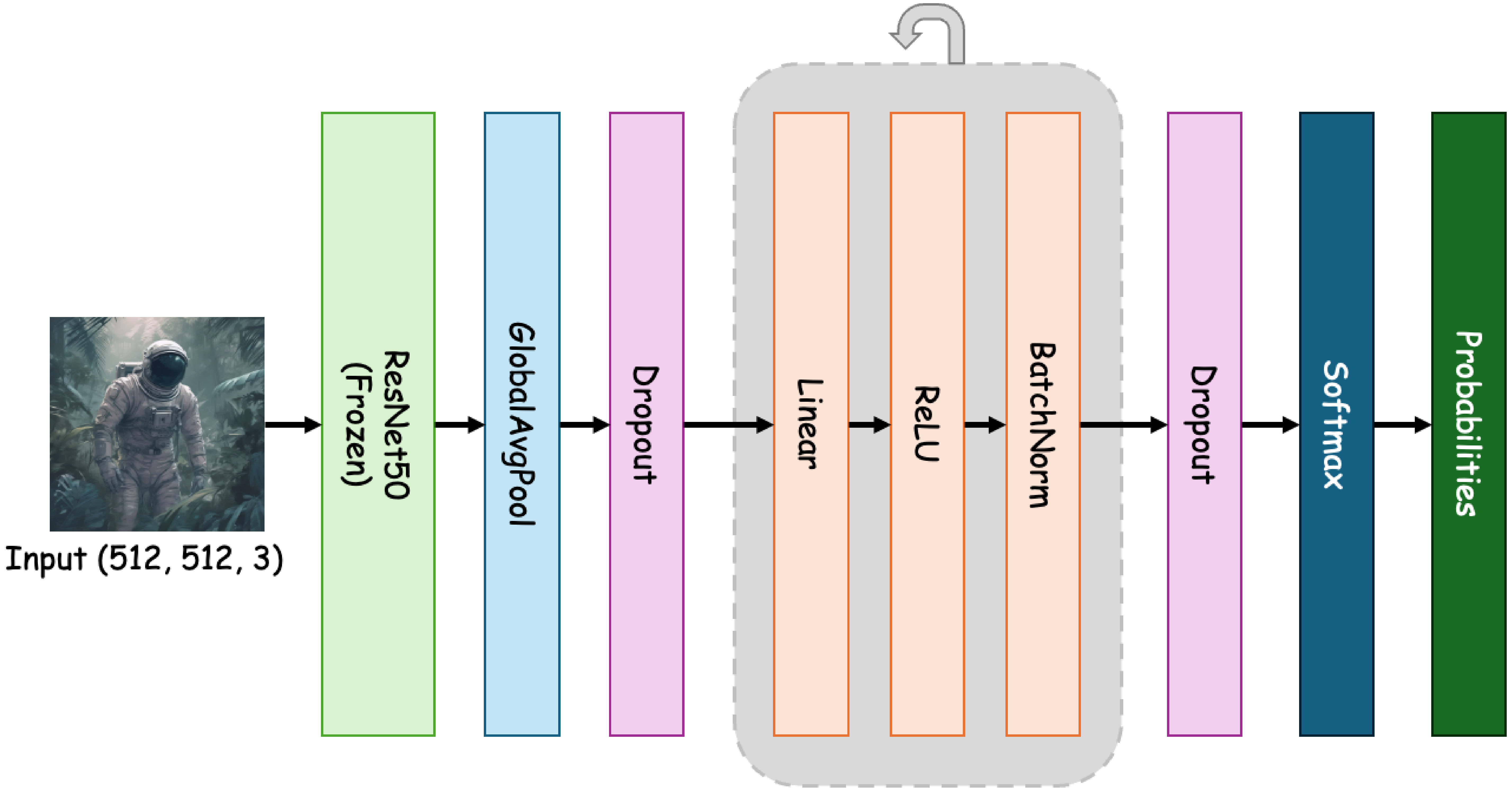
Style Transfer

Generates stylized output

Key Innovation:

Unlike traditional style transfer systems that focus solely on visual features, our approach creates a bridge between computational art generation and human emotional experience by considering the emotional congruence between content and style images.

Emotion Analysis Model



Training Strategy

Dataset: Emotion6 (Chen, n.d.)

- 1980 images (330 per emotion category)
- Six basic emotions: anger, disgust, fear, joy, sadness, surprise
- Each image has dominant emotion and probability distribution

Hybrid Loss Function

KL Divergence Loss (0.7)
Optimizes probability distribution matching

+

Cross-Entropy Loss (0.3)
Optimizes dominant emotion classification

The hybrid approach balances distribution learning with accurate dominant emotion prediction

Data Augmentation

- Original images plus 30° rotated versions
- All images resized to 512×512 resolution
- Standard normalization for pretrained model compatibility

Performance Results

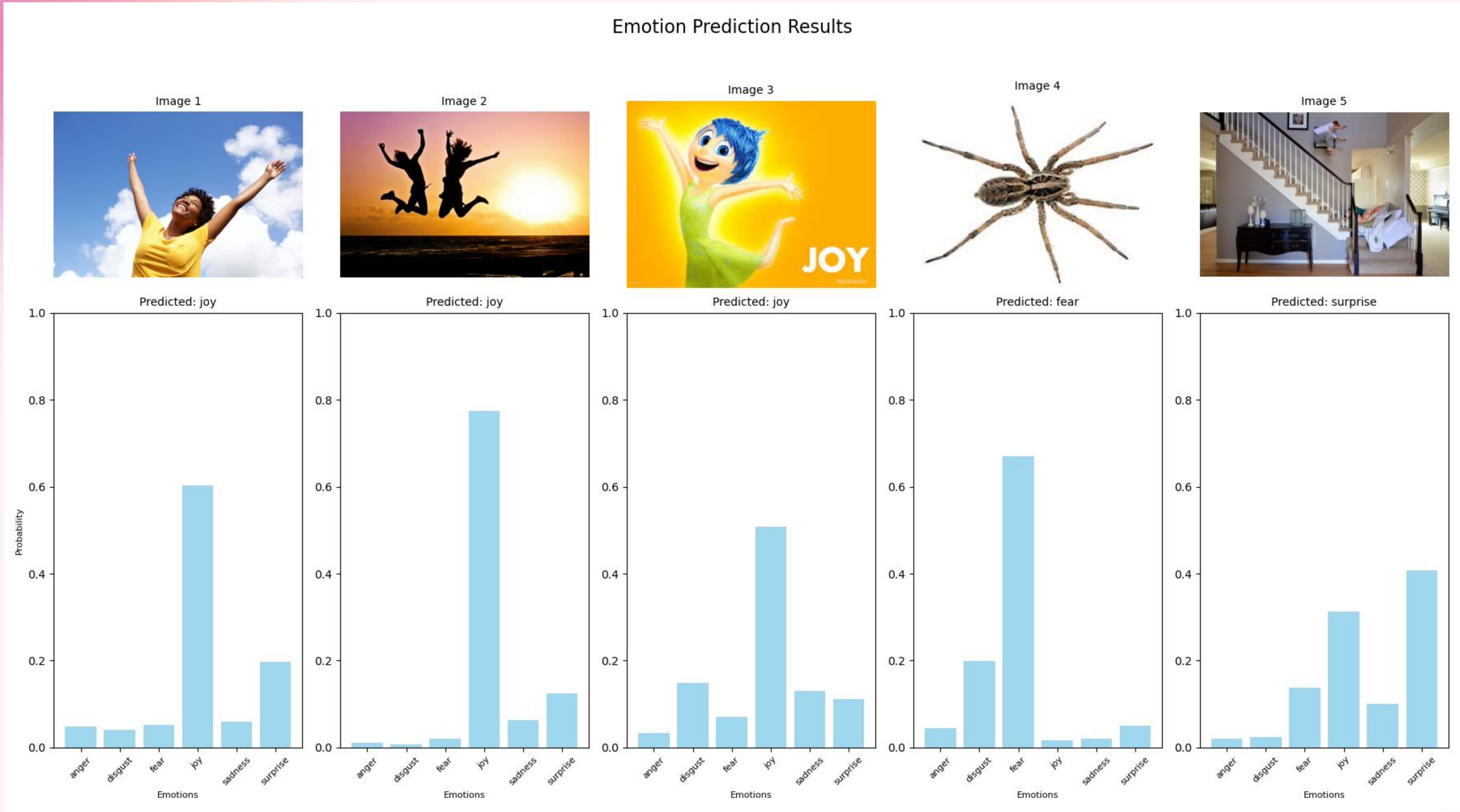
TRAINNING STRATEGY

	KL only	CE only	**Hybrid (selected)**
TRAIN LOSS	0.0653	0.5718	**0.3582**
VAL LOSS	0.1444	0.6633	**0.4514**
TRAIN ACC	0.7027	0.6692	**0.7020**
VAL ACC	0.5707	0.5808	**0.5859**

Key Finding:

The hybrid loss approach achieved the best balance between distribution learning and dominant emotion prediction. This is particularly important for our application, as the emotional matching system relies on accurate probability distributions rather than just dominant emotion classification.

Emotion Analysis Model



Emotion Similarity Matching

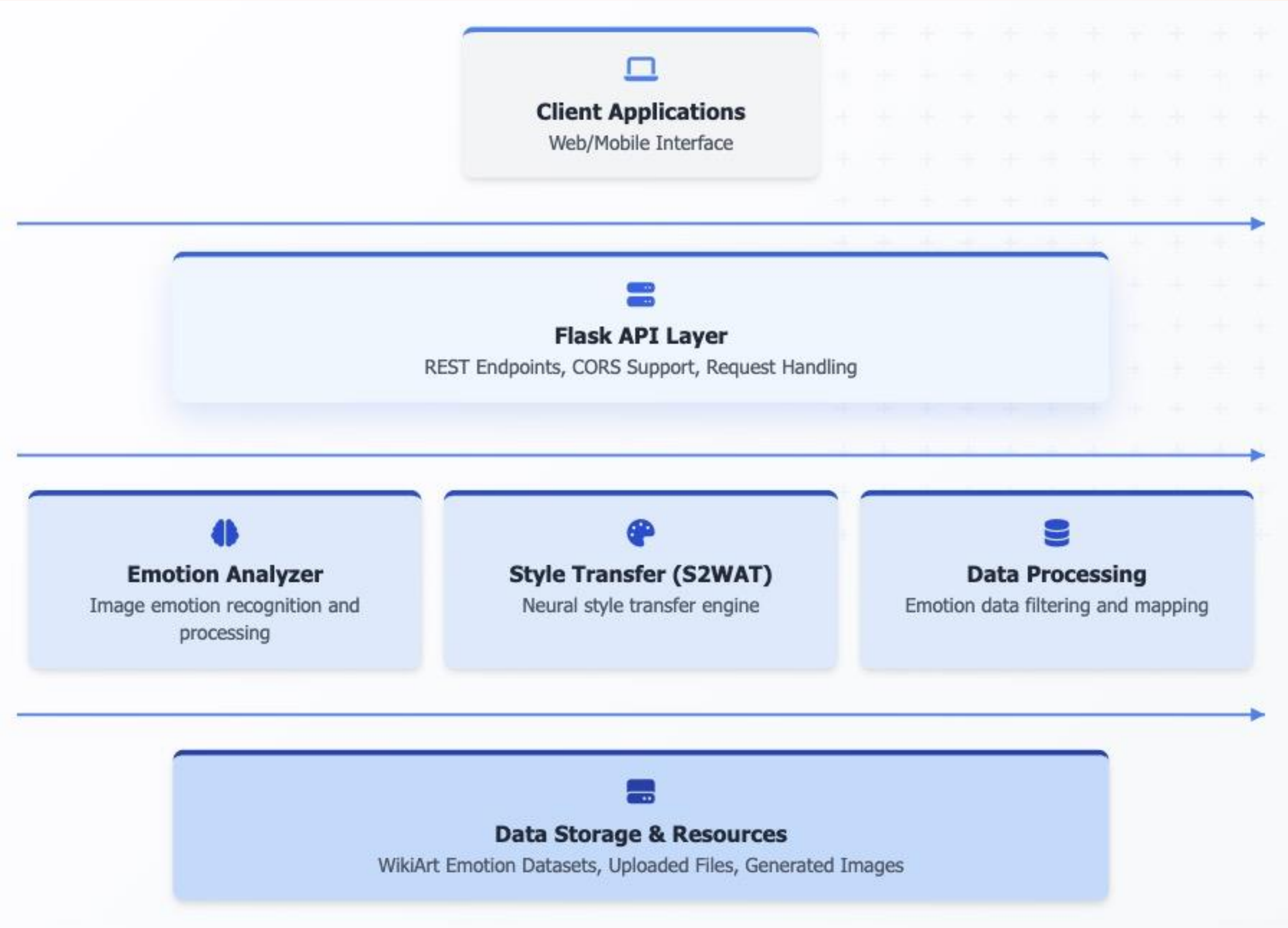
WikiArt Emotions dataset (Mohammad, 2018) pre-prosessing:
20 emotions → filter to 6 → normalize distributions

Emotion Probabilities → Calculate Similarities (Euclidean Distance) → Select Min → Return Best Match Image URL

Style Transfer Module (S2WAT)

() () (Zhang, 20

Application Architecture



API Endpoints and Workflow

Upload Image

POST

/api/upload

Handles image upload with size validation, format checking, and secure storage.

Analyze Emotion

POST

/api/analyze-emotion

Processes image to detect emotions, returns emotion probability distribution.

Apply Style Transfer

POST

/api/style-transfer

Applies selected artistic to an upload image using S2WAT model.

Get Emotion Artworks

GET

/api/emotion-artworks/{emotion}

Retrieves artwork recommendations based on specified emotion.

Integration Architecture

All components work seamlessly together through a modular design pattern. The Flask backend orchestrates component interactions, handling API requests, input validation, and coordinating cross-component workflows for a complete emotion-to-art pipeline.

Demo

System Strengths

Emotional Intelligence
Creates meaningful connections between images based on emotional content rather than just visual features

Aesthetic Quality
Produces aesthetically pleasing results with emotional consistency using state-of-the-art S2WAT model

Rich Artwork Database
Utilizes WikiArt Emotions dataset with ne-grained emotional annotations for diverse style matching

Intuitive User Experience
Provides clear visualization of emotional analysis and interactive comparison of original and stylized images

System Limitations

Limited Emotion Spectrum
Restricted to six basic emotions, missing complex or mixed emotional states that are common in real-world images

Variable Transfer Quality
Style transfer quality varies based on content-style image compatibility, despite emotional congruence

Computational Demands
S2WAT model requires computational resources, limiting real-time processing on consumer hardware

Cultural Bias
Emotional interpretation may be culturally influenced, affecting the universality of the emotion matching

Reference

- Mohammad, S. M., & Kiritchenko, S. (2018). WikiArt Emotions: An annotated dataset of emotions evoked by art. In Proceedings of the Eleventh International Conference on Language Resources and Evaluation (LREC 2018). Miyazaki, Japan.
- Zhang, C., Xu, X., Wang, L., Dai, Z., & Yang, J. (2023). S2WAT: Image Style Transfer via Hierarchical Vision Transformer using Strips Window Attention [arXiv preprint arXiv:2210.12381]. https://arxiv.org/abs/2210.12381
- Chen Lab, Cornell University. (n.d.). Emotion6 [Dataset]. Retrieved April 22, 2025, from http://chenlab.ece.cornell.edu/people/kuanchuan/publications/Emotion6.zip